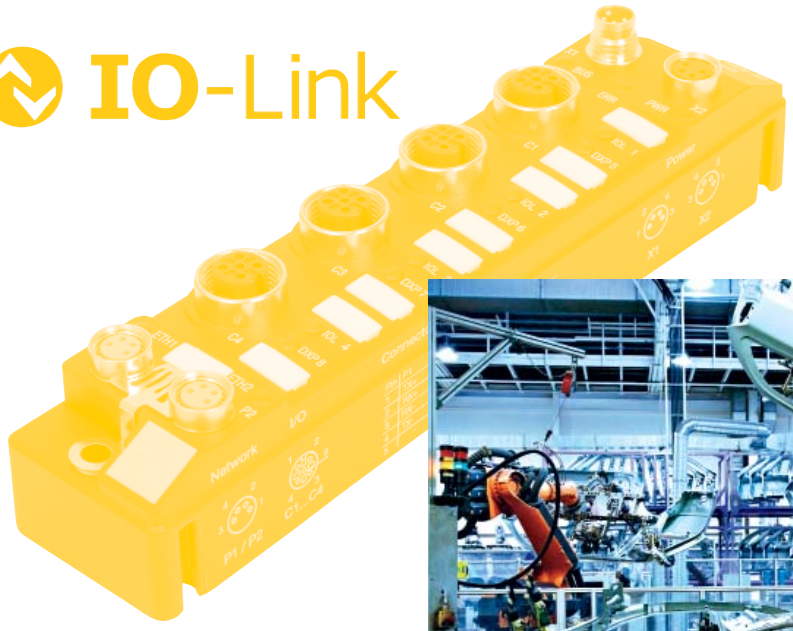
TURCK

Industrial Automation

USER MANUAL

TBEN-S2-4IOL

IO-Link



Sense it! Connect it! Bus it! Solve it!

Edition 08/2015

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1 About this manual

1.1 Documentation concept

This manual contains all information about TBEN-S2-4IOL, the TURCK IO-Link Master module which is part of TBEN-S product line. It provides 4 IO-Link channels and 4 configurable digital DXP-channels.

The following chapters contain:

- A general device description and its process data image in the different Ethernet protocols,
- A short description of the communication interface IO-Link,
- A description of the IO-Link master functionality,
- A general description of the function block (FB) IOL_Call and its in- and output variables,
- A general description of the IO-Link-Master's integration in Step 7 including a description of the FB IO-Link CALL in PROFINET,
- Helpful information for the operation of IO-Link devices and a list of possible failure causes.

1.2 Explanation of symbols used

1.2.1 Warnings

Action-related warnings are placed next to potentially dangerous work steps and are marked by graphic symbols. Each warning is initiated by a warning sign and a signal word that expresses the gravity of the danger. The warnings have absolutely to be observed:

DANGER!

DANGER indicates an immediately dangerous situation, with high risk, the death or severe injury, if not avoided.

WARNING!

WARNING indicates a potentially dangerous situation with medium risk, the death or severe injury, if not avoided.

CAUTION!

WARNING indicates a potentially dangerous situation with medium risk, the death or severe injury, if not avoided.

ATTENTION!

CAUTION indicates a potentially dangerous situation with low risk, middle or low injury, if not avoided.

1.2.2 Further notes

NOTE

In NOTES you find tips, recommendations and important information. The notes facilitate work, provide more information on specific actions and help to avoid overtime by not following the correct procedure.

TECHNICAL BASICS

The technical basics offer technical information, the basics and background information. This information lead to a better understanding of the device functions for example. The experienced user can skip this information.

➤ CALL TO ACTION

This symbol identifies steps that the user has to perform.

➥ RESULTS OF ACTION

This symbol identifies relevant results of steps

1.3 General notes

Please read this section carefully. Safety aspects cannot be left to chance when dealing with electrical equipment.

This manual includes all information necessary for the prescribed use of the modules of type TBEN-S2-4IOL. It has been specially conceived for personnel with the necessary qualifications.

1.3.1 Prescribed use

The devices described in this manual must be used only in applications prescribed in this manual or in the respective technical descriptions, and only with certified components and devices from third party manufacturers.

Appropriate transport, storage, deployment and mounting as well as careful operating and thorough maintenance guarantee the trouble-free and safe operation of these devices.

1.3.2 Notes concerning planning/installation of this product

All respective safety measures and accident protection guidelines must be considered carefully and without exception.

2 Further documentation

2.1 Product family TBEN-S

- User manual D301347 -
  "TBEN-S-product family, digital and analog standard modules"

  The user manual for the TBEN-S product family describes comprehensive topics like for example:

  – General technical data
  – Mounting the TBEN-S-modules
  – Connection options at module
  – General information about Ethernet, the multiprotocol functionality and about the single protocols
  – A description of the web server
  – Information about the electrical installation

- User manual D301348 -
  „GETTING STARTED - First steps for commissioning TBEN-S-stations“

3 IO-Link

3.1 IO-Link - the fieldbus independent communication interface

TECHNICAL BASICS

IO-Link is a fieldbus-independent communication interface for sensors and actuators.
It is based on the IO-Link specification "IO-Link Interface and System Specification" version 1.1.2, November 2012, and on the IEC 61131-9 (2013-09), ed. 1.0, „Programmable controllers - part 9: Single-drop digital communication interface for small sensors and actuators (SDCI)“.
IO-Link is a point-to-point connection between an IO-Link device (e.g. sensor, I/O hub, valve terminal) and the IO-Link master. Up to now, the binary connection was only designed for transferring switching information, but IO-Link now allows 2 bytes to be transferred normally in a 2.3 ms cycle via a combined switching status and data channel.
Other information can be exchanged in addition to the process values, such as parameters or diagnostic messages.
This enables communication with sensors and actuators down to the "last meter" to be established for universal communication.

3.1.1 General technical information

TECHNICAL BASICS

- Standard I/O-connection technologies in point-to-point connection, unshielded, 20 m wire length
- Cyclic process data transfer in typ. 2.3 ms
- Parallel service data exchange without any impact on the process data
- Communication via 24 V-pulse modulation, standard UART protocol
- Communication between master and device in 3 different transmission speeds
  - 4.800 Baud (COM 1)
  - 38.400 Baud (COM 2)
  - 230.400 Baud (COM 3)

3.1.2 Data transmission

TECHNICAL BASICS

Basically 4 different types of data exist, which are transmitted either cyclically or acyclically.

– Process data → cyclic data exchange
– Value status → cyclic data exchange
– Device data → acyclic data exchange
– Events → acyclic data exchange

Process data:
The devices' process data are transmitted cyclically, whereas the process data size is defined through the device. The device process data can contain from 0 to 32 Byte (for both in- and output).

Value status:
The value status displays if process data are valid or not. It is transmitted cyclically with the process data.

Device data:
Device data are parameters, identification data and diagnostic information. The transmission is done acyclically and only on demand of the IO-Link master.

Events:
Events are error messages or warnings/maintenance data. Error messages are transmitted from the device to the PLC or similar via the IO-Link master. The IO-Link master itself can also transmit events and status information. Those events can be for example an open circuit, communication loss or an overload.

3.1.3 Transmission media

TECHNICAL BASICS

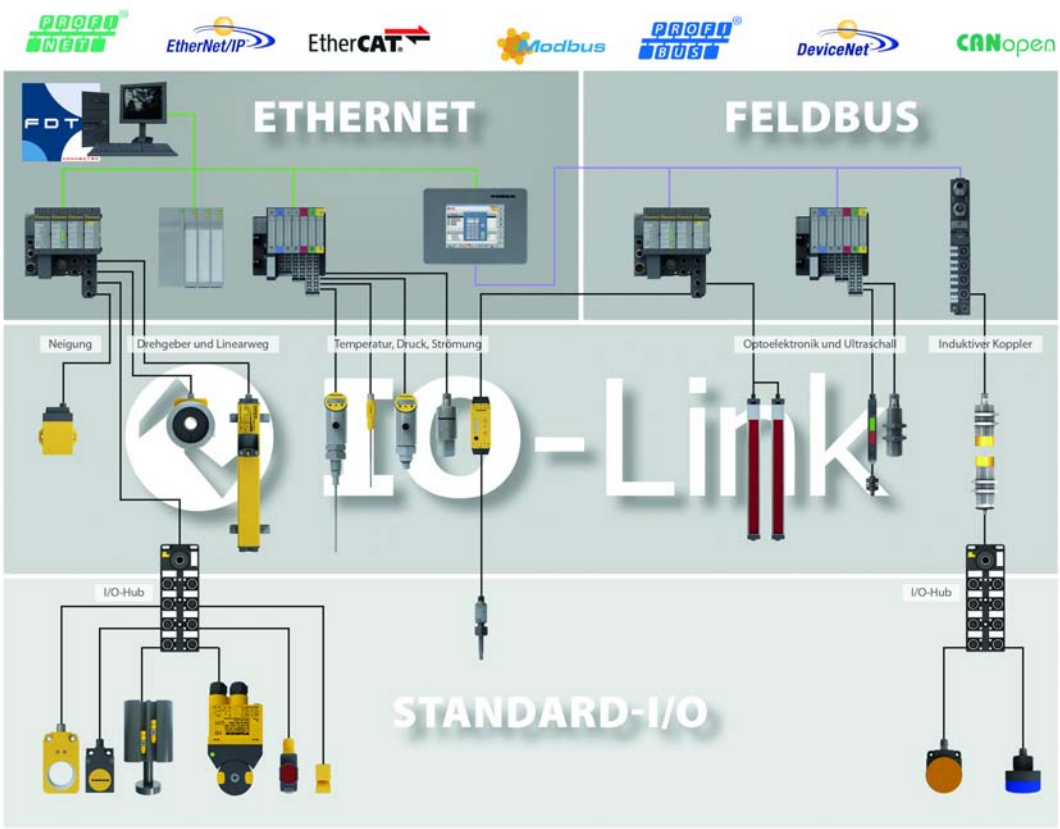
IO-Link does not require any special wiring. The sensors and actuators can continue to be connected using the proven, attractively priced and unshielded industrial cables.
The operating modes available for selection are the standard switch mode and the communication mode.

3.1.4 Fieldbus/Ethernet integration

TECHNICAL BASICS

– Usage of the standard-transport mechanisms of established fieldbusses/sensor/actuator busses
– (DPV0, DPV1, Ethernet …)
– Simple integration in engineering systems by means of configuration files (GSD, GSDML, …)
– Comfortable usage of even complex product features by means of tool based engineering (FDT/DTM, …)

Figure 3-1:
IO-Link overview



4 TBEN-S2-4IOL

4.1 General

The TBEN-S2-4IOL is the four-channel IO-Link-master module of the product family TBEN-S.

Like all modules of the TBEN-S-product family, the TBEN-S2-4IOL is a device with multiprotocol functionality. An integrated Ethernet-switch allows the building up of a line topology.

In addition to the four IO-Link-channels, the TBEN-S2-4IOL provides four universal digital DXP-channels (PNP).

The four IO-Link channels can be parameterized independently and can optionally be operated in IO-Link mode (IOL) or in standard I/O mode (DI mode).

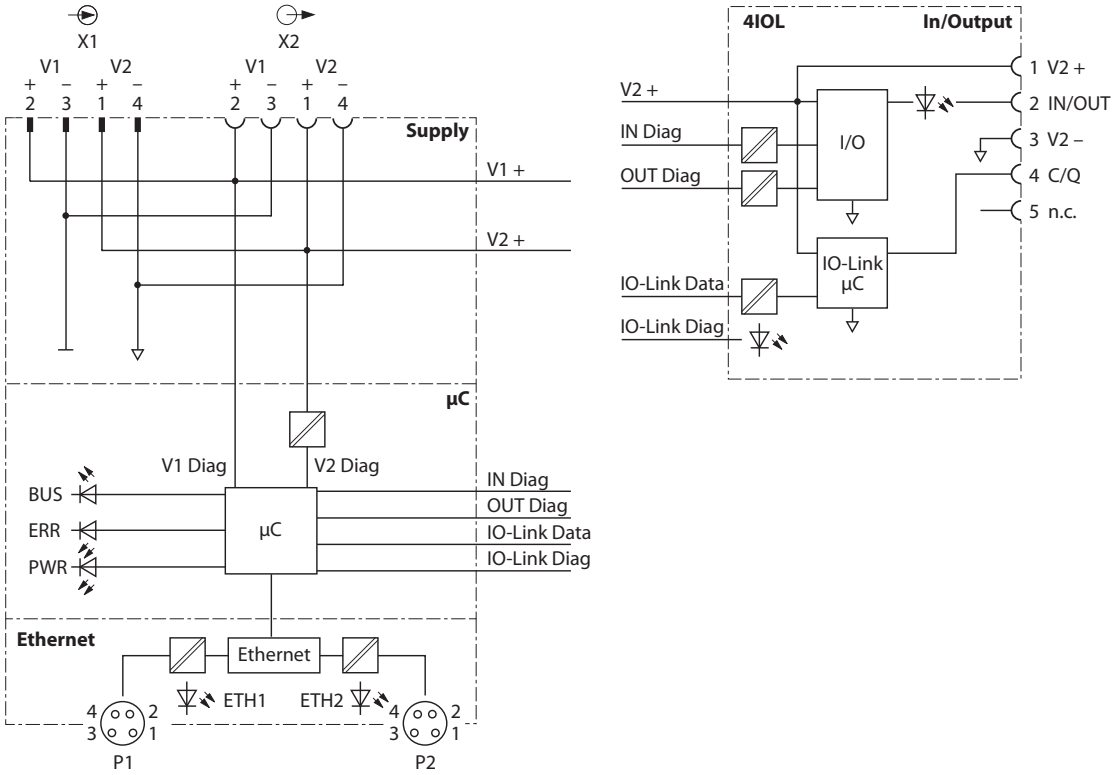
The four universal digital channels are designed as DXP-channels and can therefore be parameterized as in- or output.

Properties:

- 4-channel IO-Link master according to IO-Link specification V1.1
- 4 universal digital channels, PNP, channel diagnostics, 0,5 A

4.2 Block diagram

Figure 4-1: Block diagram, TBEN-S2-4IOL



4.3 Technical data

Table 4-1: Technical data

Type designation	TBEN-S2-4IOL
Power supply	24 V DC from operating voltage
Permissible range	20,4 … 28,8 V DC (acc. to IO-Link standard)
Operating current	< 120 mA
Sensor/actuator supply $VAUX_2$	supply connector C1 - C4 from V2 not short-circuit proof, 4 A per group C1 - C4
Potential isolation	≥ 500 V (V2 to Ethernet and V1)
IO-Link	
Number of ports	4
IO-Link specification	V1.0, V1.1 according to IEC 61 61131-9
IO-Link port type	Class A
Frame type	supports all specified frame types
Process data for IO-Link devices	
– Input data	max. 32 Byte per channel
– Output data	max. 32 Byte per channel
Transmission rate	4,8 kbps (COM 1) 38,4 kbps (COM 2) 230,4 kbps (COM 3)
Transmission cable	length: max. 20 m standard cables, 3- or 4-wire (depending on the application), unshielded

NOTE

General technical data concerning the products of the TBEN-Sx series can be found in D301347 - "TBEN-S-product family, digital and analog standard modules"

4.4 Wiring diagram

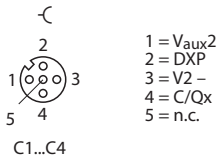
4.4.1 Ethernet/voltage supply

NOTE

Please find further information about the connectors for Ethernet and the voltage supply in the user manual D301347: "TBEN-S product family, digital and analog standard modules", chapter 5, "Connectors at the device".

4.4.2 IO-Link ports

Figure 4-2: Pin assignment of M12 x 1-connectors, 5-pole



Pin 1: VAUX2 not short-circuit proof
Pin 2: digital in- or output
Pin 4: IO-Link or digital input

ATTENTION!

Wrong supply of IO-Link devices (Class A)
Damage to the electronics
➤ The IO-Link devices (Class A) must only be supplied with the voltage provided at the supply terminals

4.5 Process data

4.5.1 Process input data

	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Module		**Status**							
	0	DXP8	DI7 (SIO)	DXP6	DI5 (SIO)	DXP4	DI3 (SIO)	DXP2	DI1 (SIO)
	1	-							
	2	-	DVS7	-	DVS5	-	DVS3	-	DVS1
	3	-							
IO-Link ports		**IO-Link process input data**							
Port 1	4 - 35	structure depends on the channel parameterization (0 - 32 byte per channel)							
Port 2	36 - 67								
Port 3	68 - 99								
Port 4	100 - 131								
		Diagnostics (see Diagnostic data (page 4-17))							
DXP-channels									
	132	ERR DXP 8	-	ERR DXP 6	-	ERR DXP 4	-	ERR DXP 2	-
	133	reserved							
IO-Link ports		(see Diagnostic data (page 4-17))							
Port 1	134	EVT1	EVT2	PDINV	HWER	DSER	CFGER	PPE	-
	135	GENER	OVL	VHIGH	VLOW	ULVE	LLVU	OTMP	PRMER
Port 2	136 - 137	assignment similar to port 1							
Port 3	138 - 139								
Port 4	140 - 141								
IO-Link ports		**IO-Link Events** (description, see Subindex 65: IO-Link Events (page 4-26))							
	142	Qualifier (1st Event)							
	143	Port (1st Event)							
	144	Event Code high byte (1st Event)							
	145	Event Code low byte (1st Event)							
	...	...							
	202	Qualifier (16th Event)							
	203	Port 16th Event)							
	204	Event Code high byte (16th Event)							
	205	Event Code low byte (16th Event)							
Module		**Module status (status word)** (see Status- and control word (page 4-21))							
	206 - 207	V2	-						Diag
		-	FCE	-	-	-	-	V1	-

Table 4-2: Process input data

Name	Value	Meaning
DIx	Digital input	
	0	No signal at DI (pin 4, SIO)
	1	Input signal at DI (pin 4, SIO)
DXPx	DXP input	
	0	No input signal at DXP-channel (pin 2)
	1	Input signal at DXP-channel (pin 2)
DVSx	Input value valid (Data Valid Signal)	
	0	The IO-Link data are valid. Possible causes: – Sensor supply is below the admissible range, – IO-Link port is parameterized as simple digital input, – No device connected to the masters, – No input data received from the connected device (only valid for devices with an input data length > 0), – No reaction from the connected device to the sending of output data (only valid for devices with an output data length > 0), – The connected device sends an error "process input data invalid.
	1	The IO-Link data are valid.
ERR DXP x	Overcurrent output	
	0	No overcurrent
	1	Overcurrent at the output (if the DXP channel is used as output)
IO-Link process input data		
Process input data of the connected device The order of the IO-Link process input data can be changed via the parameter "Process input data mapping" (page 4-9).		

4.5.2 Process output data

	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Module	0	DXP8	-	DXP6	-	DXP4	-	DXP2	-
	1	reserved							
		IO-Link process output data							
Port 1	2 - 33	Structure depends on the channel parameterization (0 - 32 byte per channel)							
Port 2	34 - 65								
Port 3	66 - 97								
Port 4	98 - 129								

Table 4-3: Process output data

Name	Value	Meaning
DXPx	DXP output	
	0	Output inactive
	1	Output active, max. output current 0.5 A
IO-Link process output data		
Process output data of the connected device The order of the IO-Link process output data can be changed via the parameter "Process output data mapping" (page 4-9).		

4.6 Parameters

The module provides 4 byte of module parameters and 16 byte of IO-Link port-parameters for each IO-Link port.

	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Module	0	SRO8	-	SRO6	-	SRO4	-	SRO2	-
	1	-							
	2	EN DO8	-	EN DO6	-	EN DO4	-	EN DO2	-
	3	-							
Port 1	4	GSD	Quick Start-Up	Data storage mode		Mode			
	5	Cycle time							
	6	Process output data mapping		Process input data mapping		Deactivate diagnostics		Process input data invalid	Revision
	7 - 11	reserved							
	12	Vendor ID (LSB)							
	13	Vendor ID (MSB)							
	14	Device ID (LSB)							
	15	Device ID							
	16	Device ID							
	17	Device ID (MSB)							
	18	reserved							
	19	reserved							
Port 2	20 - 35	Assignment similar to port 1 (byte 4 - 19)							
Port 3	36 - 51	Assignment similar to port 1 (byte 4 - 19)							
Port 4	52 - 67	Assignment similar to port 1 (byte 4 - 19)							

Table 4-4: Parameter

A *default setting*

Name	**Meaning**	
Value		
SRO	**Manual output reset after overcurrent**	
0	0 = no **A**	The output switches on automatically after an overload.
1	1 = yes	The output is manually switched-off after an overload until a new set-command is given (rise and fall).
EN DO	**Activate output**	
0	0 = no **A**	The output at pin 2 is deactivated.
1	1 = yes	The output at pin 2 is activated.

Table 4-4: Parameter

A *default setting*

Name	**Meaning**	
Value		
Mode		
0000	IO-Link without validation **A**	Pin 4 is operated in IO-Link mode. The master does not check if the connected device matches the configured one.
0001	IO-Link with family compatible device	Pin 4 is operated in IO-Link mode. The master checks if the Vendor ID and the MSB of the Device ID (this byte defines the product family) of the connected device match those of the configured one. If the master detects a mismatch, the IO-Link communication is established, but there is no process data exchange. The device remains in the safe state (Pre-Operate). Parameters and diagnostic information can be read and respectively written.
0010	IO-Link with compatible device	Pin 4 is operated in IO-Link mode. The master checks if the Vendor ID and the Device ID of the connected device match those of the configured one. If the Vendor ID matches, but the Device ID not, then the master tries to write the Device ID to the device. If the writing is successful, then the device is a compatible one, process data exchange is possible. If writing the Device ID is not successful, then process data exchange is not possible. The device remains in the safe state (Pre-Operate). Parameters and diagnostic information can be read and respectively written.
0011	IO-Link with identical device	Pin 4 is operated in IO-Link mode. The master checks if the device type (Vendor ID **and** Device ID) and the serial number of the connected device match the data of the configured one. If the master detects a mismatch, the IO-Link communication is established, but there is no process data exchange. The device remains in the safe state (Pre-Operate). Parameters and diagnostic information can be read and respectively written.
0100	DI (with parameter access)	Pin 4 is generally operated as simple digital input. However, an acyclic parameter access from the PLC or the DTM is possible. The IO-Link master starts the port in IO-link mode, parameterizes the device and sets the port back into DI-mode. The port remains in DI mode until a new IO-Link request is sent from the higher-level control. Data storage is **not** supported! Connected devices have to support the SIO-mode (DI-mode).

Table 4-4: Parameter

A *default setting*

Name	Meaning	
Value		
0101	DI:	Pin 4 is operated as simple digital input. Data storage is **not** supported!

NOTE

Parameter Mode", "DI (with parameter access)“:
In case of a parameter access, the IO-Link communication at the port is started.
Switching signals are interrupted!

Data storage mode

Synchronization of parameter data of IO-Link devices (storing the parameter of the connected device in the master).
If the synchronization is not possible, a diagnostic message is displayed (DS_{ERR}, see Diagnostic data (page 4-17)). In this case select option "11 = deactivated, clear" in order to clear the data buffer of the device.

00	activated	Synchronization of parameter data activated. The most actual data (master or device) serve as the reference data.
01	overwrite	Synchronization of parameter data activated, the data in the master serve as reference data.
10	read in	Synchronization of parameter data activated. The data in the connected IO-Link device serve as reference data.
11	deactivated, clear **A**	Synchronization of parameter data deactivated. The data set in the master is deleted.

NOTE

IO-Link devices in accordance with IO-Link specification V1.0 do not support data storage. In this case the data storage has to be deactivated (data storage mode: 11 = deactivated, clear).

Activate Quick Start-Up

For fast applications (e.g. tool changing applications) the start-up time of IO-Link devices can be shortened. The start-up time defined in the IO-Link specification (TSD = Device Detection Time) is reduced.

00	no **A**	The start-up time is within the specified range (0.5 s). All IO-Link devices in accordance with the specification can be operated.
01	yes	The start-up time is reduced to approx. 100 ms. It is not supported by every IO-Link device. It can thus be necessary to check if the used IO-Link device starts in this mode.

Table 4-4: Parameter

A *default setting*

Name	Meaning	
Value		
Device parameterization via GSD		
0	inactive **A**	The port is parameterized as generic port or not parameterized.
1	active	The port is parameterized in PROFINET with a specific device type from the GSDML-file.
Cycle time		
00	automatic **A**	The Master reads the minimum cycle time from the connected device.
00000001 - 11001111 (0×01 - 0×BF)	0.8 to 132.8 ms	Settable in steps of 0.8 or 1.6 ms. (see Table 4-5: Parameter values "cycle time" [ms] (page 4-13))
Revision		
00	automatic **A**	The Master defines the IO-Link-revision automatically.
01	V1.0	IO-Link-Revision V 1.0 is used.
Process input data invalid		
00	diagnostics generated **A**	If the process data are invalid, a respective diagnostic message is generated.
01	no diagnostics generated	Invalid process data do not cause a diagnostic message.
Deactivate diagnostics		
Influences the sending of IO-Link-Events from the master to the fieldbus. Depending on the parameterization, the master transmits Events based on their priority to the fieldbus or not.		
00	no	The master transmits all IO-Link Events to the fieldbus.
01	notifications	The master transmits all IO-Link Events to the fieldbus except for IO-Link notifications.
10	Notifications and warnings **A**	The master transmits all IO-Link Events to the fieldbus except for IO-Link notifications and warnings.
11	yes	The master doesn't transmit any IO-Link Event to the fieldbus.
Process input data mapping		
Optimization of the process data mapping for the used fieldbus: The I/O-Link-data can be swapped depending on the used fieldbus in order to achieve an optimized data mapping on the fieldbus side.		
00	direct **A**	The process data are not swapped. (0×0123 4567 89AB CDEF)
01	swap 16 bit	The bytes are swapped per word. (0×2301 6745 AB89 EFCD)

Table 4-4: Parameter	Name	Meaning	
	Value		
A *default setting*	10	swap 32 bit	The bytes are swapped per double word. (0× 6745 2301 EFCD AB89)
	11	swap all	All bytes are swapped. (0×EFCD AB89 6745 2301)
	Process output data mapping		
	see: Process input data mapping		
	Vendor ID		
	0x0000 - 0xFFFF		Enter the IDs for the port configuration check.
	Device ID		
	0x0000 - 0xFFFF		

Values for the parameter "cycle time" [ms]:

Table 4-5: Parameter values "cycle time" [ms]

Time	Value	Time	Value	Time	Value	Time	Value	Time	Value	Time	Value
auto **A**	0×00	15.2	0×56	30.4	0×7C	59.2	0×91	89.6	0×A4	120	0×B7
0.8	0×08	16	0×58	31.2	0×7E	60.8	0×92	91.2	0×A5	121.6	0×B8
1.6	0×10	16.8	0×5A	32	0×80	62.4	0×93	92.8	0×A6	132.2	0×B9
2.4	0×18	17.6	0×5C	33.6	0×81	64	0×94	94.4	0×A7	124.8	0×BA
3.2	0×20	18.4	0×5E	35.2	0×82	65.6	0×95	96	0×A8	126.4	0×BB
4	0×28	19.2	0×60	36.8	0×83	67.2	0×96	97.6	0×A9	128	0×BC
4.8	0×30	20	0×62	38.4	0×84	68.8	0×97	99.2	0×AA	129.6	0×BD
5.6	0×38	20.8	0×64	40	0×85	70.4	0×98	100.8	0×AB	131.2	0×BE
6.4	0×40	21.6	0×66	41.6	0×86	72	0×99	102.4	0×AC	132.8	0×BF
7.2	0×42	22.4	0×68	43.2	0×87	73.6	0×9A	104	0×AD	-	-
8	0×44	23.2	0×6A	44.8	0×88	75.2	0×9B	105.6	0×AE	-	-
8.8	0×46	24.0	0×6C	46.4	0×89	76.8	0×9C	107.2	0×AF	-	-
9.6	0×48	24.8	0×6E	48	0×8A	78.4	0×9D	108.8	0×B0	-	-
10.4	0×4A	25.6	0×70	49.6	0×8B	80	0×9E	110.4	0×B1	-	-
11.2	0×4C	26.4	0×72	51.2	0×8C	81.6	0×9F	112	0×B2	-	-
12.0	0×4E	27.2	0×74	52.8	0×8D	83.2	0×A0	113.6	0×B3	-	-
12.8	0×50	28	0×76	54.4	0×8E	84.8	0×A1	115.2	0×B4	-	-
13.6	0×52	28.8	0×78	56	0×8F	86.4	0×A2	116.8	0×B5	-	-
14.4	0×54	29.6	0×7A	57.6	0×90	88	0×A3	118.4	0×B6	-	-

A *automatic: The lowest cycle time supported by the device is taken from the table.*

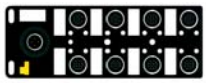
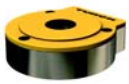
4.6.1 Adaptation of the process data mapping

The mapping of process data can be adapted application-specifically via the IO-Link-master's parameterization.

Depending on the used fieldbus, it can be necessary to swap process data word-wise, double word-wise or completely in order to align them to the data structure in the PLC.

The process data mapping is determined channel by channel through the parameters "process input data mapping" and "process output data mapping" (see Parameters (page 4-9)).

Example mapping for field buses with Little Endian-format:

Maaping from master → fieldbus → PLC		**Byte (A)**	**Devices at channel 1... 4**	**Parametrierung of the channel** (see page 4-9)	**Process output data mapping IO-Link device**	**Byte (A)**
Byte 0	Status					
Byte 1	Control					
PORT1						
Byte 2	Temperature	Low byte		2 byte process data (**swap 16 bit**)	Temperature	High byte
Byte 3		High byte				Low byte
PORT2						
Byte 4	Position	Low byte		2 byte process data (**swap 16 bit**)	Position	High byte
Byte 5		High byte				Low byte
PORT3						
Byte 6	Digital signal	1... 7		2 byte process data (**direct**)	Digital signal	1... 7
Byte 7	Digital signal	8 ...15			Digital signal	8 ...15
PORT4						
Byte 8	Diagnosis			4 byte process data (**swap all**)	Counter/ position value	MSByte
Byte 9	Counter/ position value	Low byte				High byte
Byte 10		High byte				Low byte
Byte 11		MSByte			Diagnosis	

A *Low byte, the lowest byte Low-Byte*
High byte High-Byte
MSByte: Most Significant Byte

4.7 Device status

4.7.1 LED behavior

The following table describes the protocol-independent behavior of the device LEDs.

The description of protocol-specific LED-behavior can be found in the respective sub-chapters.

Table 4-6: LED behavior

LED	Color	Status	Meaning	Remedy
PWR	green	off	V1 missing or < 18 V DC	Check V1
		on	V1 and V2 OK	-
	Red	on	V2 missing or < 18 V DC	Check V2
ETHx	green	on	Link established,100 Mbps	
		flashing	Ethernet Traffic, 100 Mbps	
	yel-low	on	Link established,100 Mbps	
		flashing	Ethernet Traffic, 10 Mbps	
	-	off	no Ethernet link	Check the Ethernet connection.
ERR	green	on	No diagnostic message available	
	red	on	Diagnostic message pending	
BUS	green	on	Active connection to a master	-
		blinking	Device is ready for operation	-
	Red	on	IP address conflict or restore mode or timeout	control IP addresses in the net-work waiting for the device to be ready for operation
		blinking	Blink-/wink-command active	see also description of LED "C8"
	red/ green	on	Autonegotiation and/or waiting for DHCP-/BootP-address assign-ment.	

Table 4-6: LED behavior

LED	Color	Status	Meaning	Remedy
IOLx	**Channel in IO-Link-mode**			
	Green	off	No IO-Link communication, diagnostics deactivated	– connect an IO-Link device – Parameterize the channel as DI if necessary.
		flashing	IO-Link communication active, valid process data	-
	Red	on	No IO-Link communication and/or module error, invalid process data	Possible causes: – Sensor supply is below the admissible range, – IO-Link port is parameterized as simple digital input, – No device connected to the masters,
	Red	flashing	IO-Link communication active and module error, invalid process data	– No input data received from the connected device (only valid for devices with an input data length > 0), – No reaction from the connected device to the sending of output data (only valid for devices with an output data length > 0), – connected device sends an error: "process data invalid". see also: Start-up problems - frequently failure causes (page 10-4)
	Channel in DI-mode			–
	Green	off	-	
	Green	on	Input signal active	–
DXPx	Green	off	-	
	Green	on	In-/ output signal active	
	Red	on	Short circuit at output of the respective channel	
DXP 8	white	flashing	Support for localizing a module if the blink-/wink-command is activated	-

4.7.2 Diagnostic data

Diagnostic messages are distinguished between DXP-diagnostics, IO-Link-master diagnostics and IO-Link-device diagnostics.
The „$PD_{invalid}$" diagnostic (process data invalid) can be sent from both devices, IO-Link master or IO-Link device.

- **DXP-diagnostics**
  Diagnostic messages of the digital channels of the module (DXP 2, 4, 6, 8).
- **Master diagnostics**
  The IO-Link-master reports problems within the IO-Link communication.
- **Device diagnostics**
  The device diagnostics map the IO-Link Event codes (according to the IO-Link specification) sent from the IO-Link devices to the diagnostic telegram of the master.
  to the diagnostic telegram of the master.
  Event codes can be read from the connected devices by using appropriate device tools (e.g. IODD-Interpreter).
  Further information about the IO-Link Event codes and their meaning can be found in the IO-Link specification or in the documentation of the connected IO-Link devices.

Diagnostic telegram

Channel	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DXP		**DXP-diagnostics**							
	0	ERR DXP 8	-	ERR DXP 6	-	ERR DXP 4	-	ERR DXP 2	-
	1	-	-	-	-	-	-	-	-
IO-Link		**Device diagnostics**				**Master diagnostics**			
IO-Link port 1	0	EVT1	EVT2	PDINV	HWER	DSER	CFGER	PPE	-
	1	GENER	OLV	VHIGH	VLOW	ULVE	LLVU	OTMP	PRMER
IO-Link port 2	2 + 3	assignment similar to port 1							
IO-Link port 3	4 + 5	assignment similar to port 1							
IO-Link port 4	6 + 7	assignment similar to port 1							

Table 4-7: Diagnostic data

Bit	Meaning	Remedy
DXP-diagnostics		
ERR DXP x	Overcurrent output	
	0	No overcurrent
	1	Overcurrent at the output (if the DXP channel is used as output)

Table 4-7: Diagnostic data

Bit	Meaning	Remedy
Master diagnostics		
PPE	port parameterization error	
	The port parameters are inconsistent. The device parameterization via GSD is active, but not working. Possible causes: The IO-Link-master did not receive GSDML-parameters for a connected device. The connected device was not parameterized by a PROFINET PLC via GSDML. The port is in operation mode "IO-Link without validation" or "DI". These modes do not allow parameterization via GSD. The data storage mode is active, which means, the parameter is not set to "deactivated, clear". A device parameterization via GSDML is not possible with activated data storage. Vendor or Device ID are "0". The connected device can not be identified and is thus not parameterizable.	
CFGER	Wrong or missing device	
	The connected device does not match the channel configuration or there is no device connected to the channel. This diagnostic message depends on the parameterization of the channel (see parameters, page 4-10).	Change the parameterization of the IO-Link port at the master. Correct the vendor-ID, device-ID, etc. The parameterization can be done by teaching the master via IOL_CALL using the port function Subindex 67: Teach Mode or via a manual port parameterization.
DSER	data storage error	
	Possible causes:	
	– Data storage mismatch	IO-Link device in accordance with IO-Link V1.0 connected. Deactivate the data storage. To do so, set parameter "Data storage mode" to "deactivated, clear", see page 4-11.
		The data storage buffer contains data of another device. Clear the data storage buffer of the master. To do so, set the parameter "Data storage mode" to "deactivated, clear", see page 4-11, and re-activate the data storage if necessary.

Table 4-7: Diagnostic data

Bit	Meaning	Remedy
	– Overflow of the data storage buffer	Clear the data storage buffer of the master. To do so, set the parameter "Data storage mode" to "deactivated, clear", see page 4-11, and re-activate the data storage if necessary.
	– Parameter access for data storage not possible	The connected device may be locked for parameter changes or for data storage. Check the status of the IO-Link index "Device Access Locks" (index 0×C) of the connected device and unlock the device.
Master/device diagnostics		
PDINV	process input data invalid	
	The IO-Link master or the IO-Link device report invalid process input data.	The connected device is not in status "operate", which means, it is not ready for operation. Possible sources: The connected device does not match the configured one, additional diagnostic message Wrong or missing device.
		Certain IO-Link devices send a "process input data invalid"-diagnosis if the process value cannot be measured. Deactivate the sending of the "process input data invalid"-diagnosis for the respective port. To do so, change the parameter "Process input data invalid" to "no diagnostics generated", see page 4-12.
Device diagnostics		
For the exact specification of the device diagnostics, please read the device documentation of the device manufacturer.		
HWER	hardware error	
	General hardware error or device malfunction.	
EVT2	out-of-specification events	
	An Out-of-Specification Event in accordance with the IO-Link specification occurred.	
EVT1	maintenance events	
	A Maintenance Event in accordance with the IO-Link specification occurred, maintenance necessary.	
PRMER	parameterization error	
	The connected device reports a parameterization error (loss of parameters, no parameter initialization, etc.)..	

Table 4-7: Diagnostic data

Bit	Meaning	Remedy
OTMP	overtemperature	
	Temperature diagnostic message at the connected device.	
LLVU	lower limit value underrun	
	The process value lies under the parameterized measurement range or the chosen measurement range has been chosen too high.	
ULVE	upper limit value exceeded	
	The process value exceeds the parameterized measurement range or the chosen measurement range has been chosen too low.	
VLOW	undervoltage	
	One of the voltages at the connected device is below the defined range.	
VHIGH	overvoltage	
	One of the voltages at the connected device is below the defined range.	
OLV	Overload	
	The connected device detected an overload.	
GENER	Common error	
	The device sends an error (device status 4, in accordance with IO-Link specification), which is not clearly specified. Read out the device event codes in order to be able to specify the error more precisely.	

4.7.3 Status- and control word

Status word

EtherNet/IP™ Modbus	PROFINET	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Byte 1	V2	-						DIAG
Byte 1	Byte 0	-	FCE	-	-	-	COM	V1	-

Table 4-8: Status word bits

Name	Value	Description
COM	0	-
	1	Internal error, the device-internal communication is disturbed.
DiagWarn	0	-
	1	Diagnostics available at the device.
FCE	0	-
	1	The Force Mode is activated, which means, the actual output values may no match the ones defined and sent by the field bus.
V_1	0	-
	1	System power supply too low (< 18 V DC).
V_2	0	-
	1	V2 too low (< 18 V DC).

Control word

No function

The status word is mapped into the module's process data.

- EtherNet/IP™
  In EtherNet/IP™, the mapping can be disabled (seeGateway Class (VSC 100), GW Status Word (page 6-18) and GW Control Word (page 6-18)).

ATTENTION!

Activate/deactivate the Status and Control Word in EtherNet/IP™

Changes in the process data mapping

➤ Observe that activating/deactivating the Status and Control Word causes changes in the process data mapping.

- Modbus TCP
  → see Register 100Ch: Module status (page 5-6)
- PROFINET
  → see PROFINET-diagnostics - TBEN-S2-4IOL (page 7-5)

4.8 IO-Link data storage

4.8.1 General

Data storage enables a user to change an IO-Link device when maintenance is required without any configuration or parameterization.

The IO-Link master, as well as the IO-link device, store the device parameters. The data storage mechanism serves for synchronizing these different data storage buffers.

In case of a device change, the master writes the stored device parameters to the new device. The application can be re-started without any further intervention using a configuration tool or similar.

In the IO-Link master, the data storage mode can be set using the parameter "data storage mode" (see Parameters (page 4-9)).

data storage mode

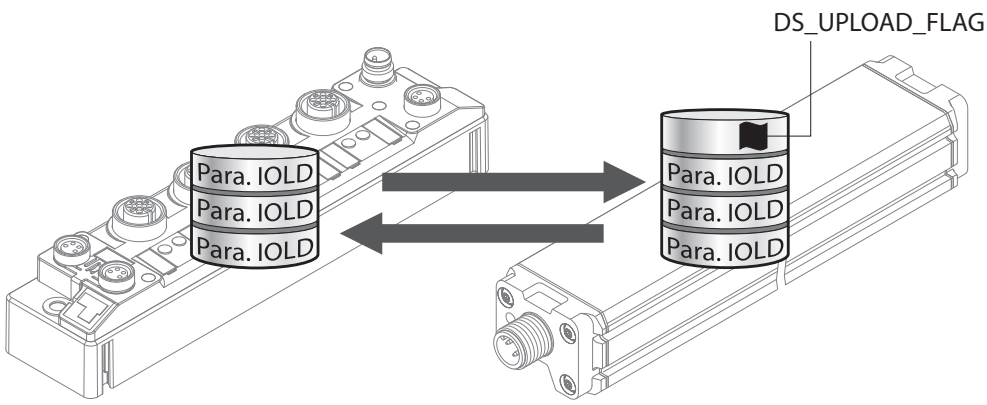
00 = activated (page 4-23)

01 = overwrite (see page 4-25)

10 = read in (see page 4-25)

11 = deactivated, clear (see page 4-25)

Figure 4-3: General principle of the data storage mechanism



Para. IOLD = parameter data of the IO-Link device

A change of parameters in the device is indicated by the status of the **DS_UPLOAD_FLAG** bit:

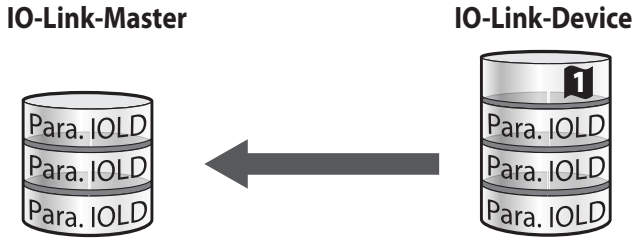
DS_UPLOAD_FLAG:
0 = no changes in the device's parameter set
1 = changes in the device's parameter set (e. g. via DTM, at the device, etc.)

4.8.2 Parameter "data storage mode" = activated

- The synchronization of the parameter sets is bidirectional.
- The most actual data set (master or device) is valid:
  This means:
  - The *data set in the device* is actual, if DS_UPLOAD_FLAG = 1
  - The *data set in the master* is actual, if DS_UPLOAD_FLAG = 0

Parameterizing a device in the installation:
A device, which is already used in the installation, is for example parameterized via a DTM.

DS_UPLOAD_FLAG = 1
→ changes in the device's parameter see

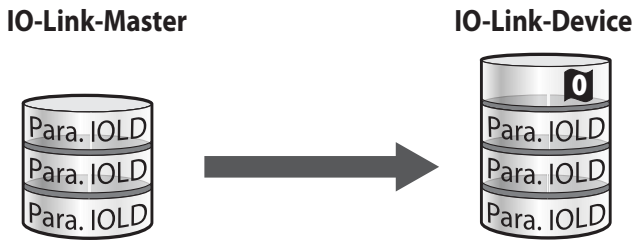


The IO-Link device is already connected to the master.

Para. IOLD = parameter data of the IO-Link device

Maintenance - exchange device in delivery status:
A defective device is replaced by a device in delivery status.

DS_UPLOAD_FLAG = 0
→ no changes in the device's parameter set

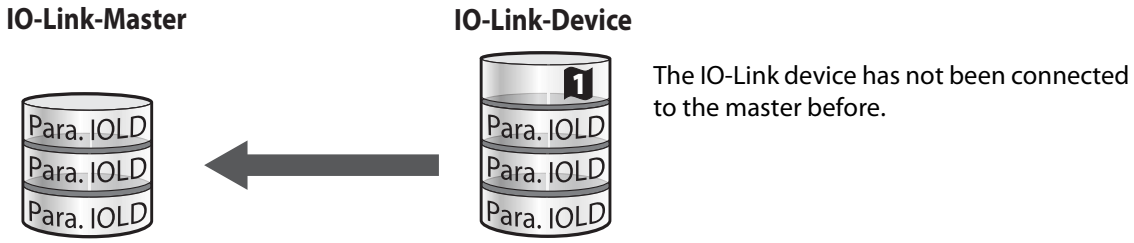


The IO-Link device has not been connected to the master before.

Para. IOLD = parameter data of the IO-Link device

Maintenance - exchange device with eventually modified parameter set:
A defective device is replaced by a device with a parameter set that was already changed before (for example via DTM).

DS_UPLOAD_FLAG = 1
→ changes in the device's parameter see



Para. IOLD = parameter data of the IO-Link device

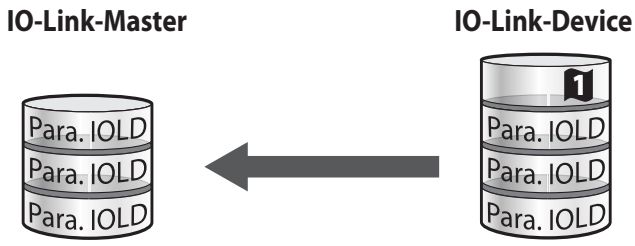
NOTE

If a device change is necessary when data storage is activated, the following has to be observed:
An IO-Link exchange device with unknown parameter data should be reset to factory defaults before connecting it to the master.
This prevents unknown device parameter settings to be downloaded to the master when establishing the connection.
TURCK IO-Link devices can be reset to factory settings via a system command using a generic IO-Link-DTM and the device-specific IODD.
For the reset of third party devices, please read the corresponding manufacturer documentation.

4.8.3 Parameter "data storage mode" = read in

- The data set in the device is **always** the reference data set.
- The synchronization of the parameter sets is unidirectional towards to the master.
- The status of the DS_UPLOAD_FLAG is ignored.

Figure 4-4: "Data storage mode" = read in

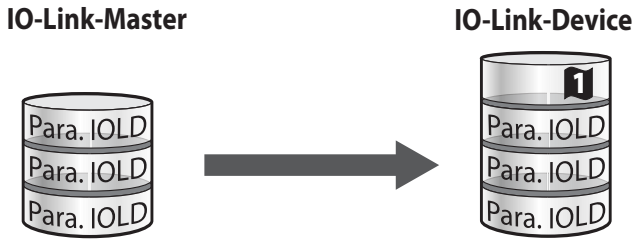


Para. IOLD = parameter data of the IO-Link device

4.8.4 Parameter "data storage mode" = overwrite

- The data set in the master is **always** the reference data set.
- The synchronization of the parameter sets is unidirectional towards to the device.
- The status of the DS_UPLOAD_FLAG is ignored.

Figure 4-5: "Data storage mode" = overwrite

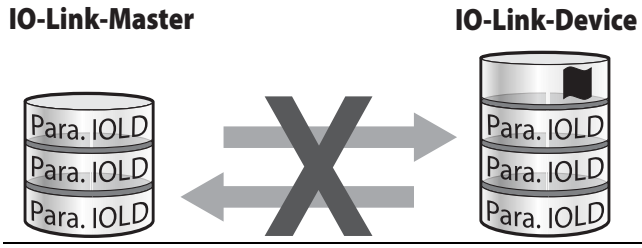


Para. IOLD = parameter data of the IO-Link device

4.8.5 Parameter "data storage mode" = deactivated, clear

- The data set in the master is deleted.
- The synchronization of parameter sets is deactivated.

Figure 4-6: "Data storage mode" = deactivated, clear



4.9 IO-Link - functions for acyclic communication

The acyclic access to the data of IO-Link devices is realized via IO-Link CALLs.

Therefore it is necessary to distinguish between data of an IO-Link master or of an IO-Link device.

The addressing of the IO-Link CALL is realized via the so called Entity_Port- It defines which device is addressed via the CALL:

Entity_Port 0 = IO-Link master module (IOLM - TBEN-S2-4IOL)

Entitiy_Port 1 = IO-Link device at 1st channel

Entitiy_Port 2 = IO-Link device at 2nd channel

Entitiy_Port 3 = IO-Link device at 3rd channel

Entitiy_Port 4 = IO-Link device at 4th channel

4.9.1 Port functions for port 0 (IO-Link master)

Subindex 64: Master Port Validation Configuration

Table 4-9: Master Port Validation Configuration

Entity_ Port	IO-Link subindex	Read Write	Length	Description
0	64	w	max. 72 byte	This object serves for writing a defined configuration of the IO-Link ports into the master.

Subindex 65: IO-Link Events

Table 4-10: IO-Link Events

Entity_ Port	IO-Link subindex	Read Write	Length	Description
0	65	r	255 byte	This object serves for reading the IO-Link events.

NOTE

On "appears" (coming diagnostics) and "Single Shot Events" are shown, as long as they are pending.

Structure of the read data:

- Byte 0 contains 2 bit per IO-Link port which show, if the process data of the connected device are valid or not.
- Byte 0 is followed by 4 byte per Diagnostic Event which clearly assign and specify the diagnostic message.
  A maximum of 14 Events **per IO-Link** port are shown.

Byte	**Bit**								
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
0								x	PD_Valid input port 1
							x		PD_Valid output port 1
						x			PD_Valid input port 2
					x				PD_Valid output port 2
				x					PD_Valid input port 3
			x						PD_Valid output port 3
		x							PD_Valid input port 4
	x								PD_Valid output port 4
1	reserved								
2	Qualifier								Defines the type of the Event (Warning, Notification, Single Shot Event, etc.) in accordance with IO-Link specification „IO-Link Interface and System“.
3	Port								Indication of the IO-Link port which sends an Event.
4	Event Code high byte								High or respectively low byte of the Event Code sent.
5	Event Code low byte								
...									
223	Qualifier								see byte 2 - 5
224	Port								
225	Event Code high byte								
226	Event Code low byte								

Subindex 66: Set Default Parameterization

Table 4-11: Set Default Parameterization

Entity_ Port	IO-Link subindex	Read Write	Length	Description
0	66	w	4 byte	Writing this object sets the IO-Link master back to factory settings. Any parameter setting and configuration is overwritten. The data storage buffer is deleted as well.

Structure of the reset command:

Byte 3	Byte 2	Byte 1	Byte 0
0xEF	0xBE	0xAD	0xDE

Subindex 67: Teach Mode

Table 4-12: Teach Mode

Entity_ Port	IO-Link subindex	Read Write	Length	Description
0	67	w	1 byte	The master reads all data (device-Id, vendor-ID, serial number, etc.) from the connected device and saves them. All all previously saved device data are overwritten.

Structure of the Teach command:

Byte 0	
0x00	Teaching all 4 ports
0x01	Teaching port 1
0x02	Teaching port 2
0x03	Teaching port 3
0x04	Teaching port 4
0x05 - 0xFF	reserved

Subindex 68: Master Port Scan Configuration

Table 4-13: Master Port Scan Configuration

Entity_ Port	IO-Link subindex	Read Write	Length	Description
0	68	r	max. 120 byte	This object serves for reading the configuration of the IO-Link devices connected to the IO-Link master.

28 byte are returned per IO-Link port

Table 5: Structure of the response telegram

IO-Link Port	Content	Length	Format	Description
Port 1	Vendor_ID	2 byte	UINT16	Vendor ID of the connected device
	Device_ID	4 byte	UINT32	Device-ID of the connected device
	Function_ID	2 byte	UINT16	reserved
	Serial_Number	16 byte	String	Serial number of the connected device
	COM_Revision	1 byte	UINT8	IO-Link version
	Proc_In_Length	1 byte	UINT8	Process input data length of the connected device
	Proc_Out_Length	1 byte	UINT8	Process output data length of the connected device
	Cycle time		UINT8	Cycle time of the connected device
Port 2	Structure similar to port 1			
Port 3				
Port 4				

Subindex 69: Extended Port Diagnostics

Table 4-1: Extended Port Diagnostics

Entity_ Port	IO-Link subindex	Read Write	Length	Description
0	69	r	max. 8 byte	This object serves for reading the Extended Port Diagnostics.

Structure of the Extended Port Diagnostics:

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	NO_SIO	TCYC	-	-	DS_F	NO_DS	-	-
Byte 1	-	WD	MD	PDI_H	-	PDI_E	NO_PD	-
Byte 3								
Byte 4	Device status according to IO-Link specification (see Device Status (page 4-31))							

Table 4-2: Meaning of the Extended Port Diagnostics

Diagnostic bit	Meaning
NO_DS	The parameterized port mode (see Parameters (page 4-9)) does not support data storage. Remedy: – Change the parameterization of the port.
DS_F	Error in the data storage, synchronization not possible Possible causes: – Connected device does not support data storage – Overflow of the data storage buffer Remedy: – Connect a device that supports data storage. – Clear the data storage buffer. – Deactivate the data storage.
TCYC	The device does not support the cycle time parameterized in the master. Remedy: – Increase the cycle time set in the master
NO_SIO	The device does not support the standard DI mode (see parameter Mode (page 4-9)). Remedy: – Select the IO-Link mode for this port.
NO_PD	No process data available The connected device is not ready for operation. Remedy: – Check the configuration
PDI_E	The connected device reports invalid process data in accordance with IO-Link specification V1.0.
PDI_H	The connected device reports invalid process data in accordance with IO-Link specification V1.1.

Table 4-2: Meaning of the Extended Port Diagnostics

Diagnostic bit	Meaning
MD	Missing device: No IO-Link device detected Remedy: – Check the IO-Link cable. – Change the device.
WD	Wrong device detected: one or more parameters of the connected device (Vendor ID, Device ID, serial number) does not/do not match the data which are stored in the master for this device. Remedy: – Change the device. – Adapt the master parameterization (see parameter Mode (page 4-9))

Device Status

Table 4-3: Device Status

Value	Meaning
0	Device works correctly
1	Maintenance Event
2	Out-of-Specification Event
3	Functional check
4	Error
5-255	reserved

4.10 IO-Link and TURCK device DTMs

TECHNICAL BASICS

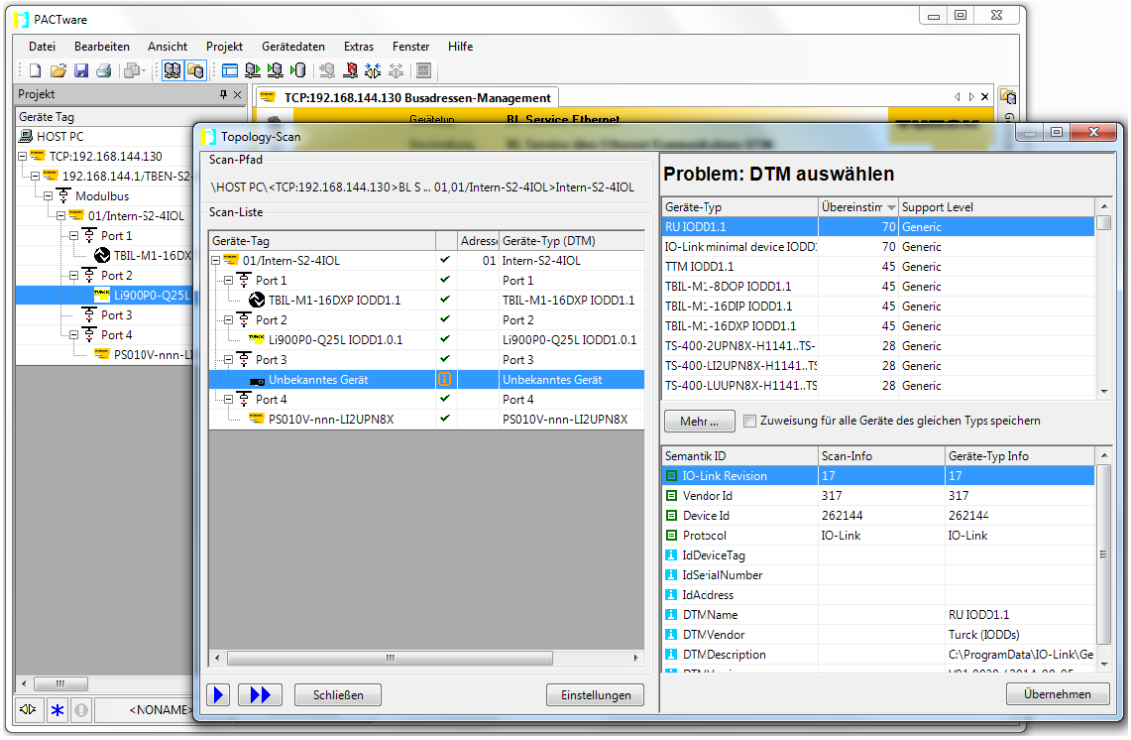
FDT enables a fieldbus and system independent engineering environment to be set up. Generic DTMs allow any type of sensor and actuator to be integrated easily in the system.

4.10.1 Topology-Scan

The Topology Scan in PACTware also allows the read-in of an IO-Link configuration down to the IO-Link device.

IO-Link device, known in PACTware, are added to the IO-Link ports of the master.
Therefore, either the respective sensor DTMs in PACTware or the sensor IODDs via IODD DTM Configurator have to be installed.

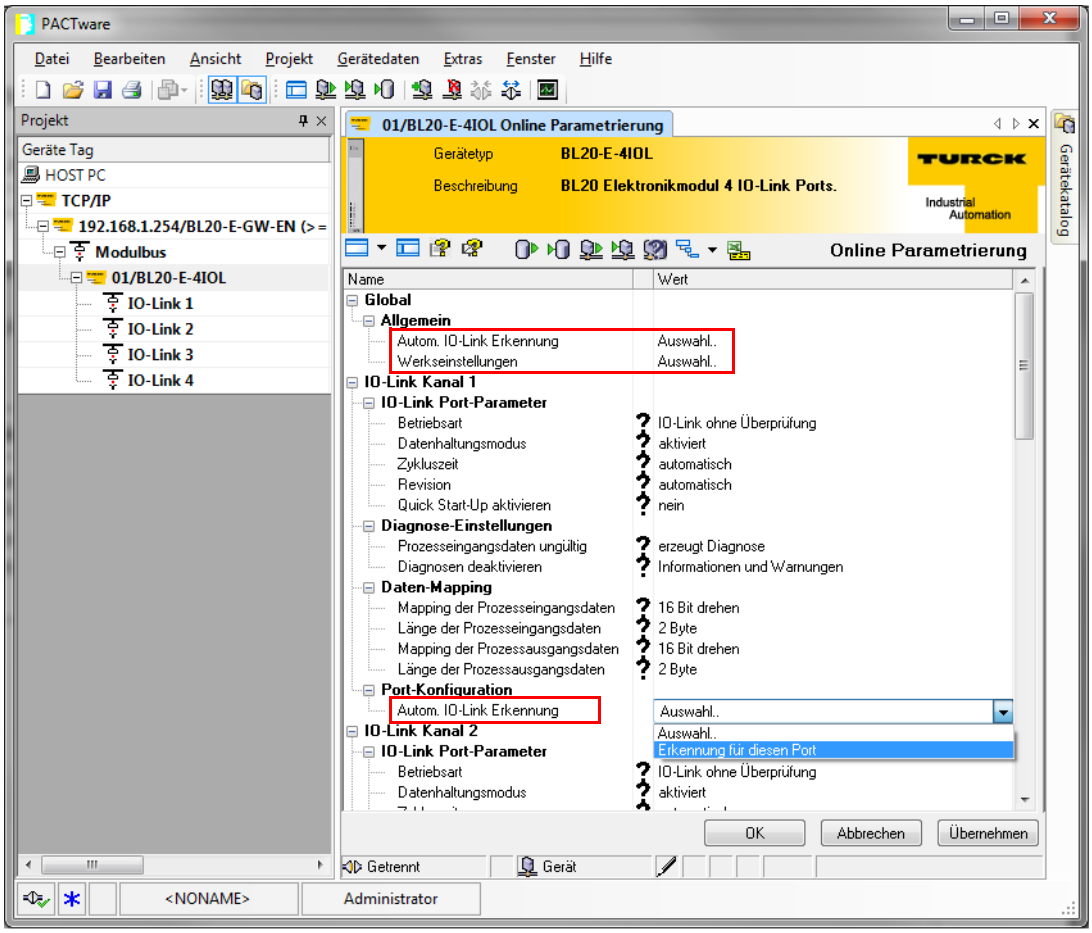
Figure 4-7: Topology Scan in PACTware



4.10.2 Special DTM parameters

The TURCK DTMs offer, besides the normal parameters of the IO-Link master modules, special function for configuring the master module.

Figure 4-8: Special DTM functions



Automatic IO-Link detection

The data of the connected device/ the connected devices are read-in by the master.
read in
This function affects, depending on the parameter group in which it is activated, all ports or only one special port. In the "Common"-group it is valid for the whole module, in the "Port configuration" group it is only valid for the respective port.

Factory settings

The master is set back to its factory settings.

5 Modbus TCP

5.1 General

5.1.1 Implemented Modbus functions

The TBEN-S modules for Modbus TCP support the following functions for accessing process data, parameters, diagnostics and other services.

Table 5-1: Implemented functions

Function Codes	
No.	**Function**
	Description
1	**Read Coils**
	Reading multiple output bits.
2	**Read Discrete Inputs**
	Reading multiple input bits.
3	**Read Holding Registers**
	Reading multiple output registers.
4	**Read Input Registers**
	Reading multiple input registers.
5	**Write Single Coil**
	Writing a single output bit.
6	**Write Single Register**
	Writing a single output register.
15	**Write Multiple Coils**
	Writing multiple output bits.
16	**Write Multiple Registers**
	Writing multiple output registers.
23	**Read/Write Multiple Registers**
	Reading and writing of multiple registers.

5.1.2 Modbus registers

NOTE

For the register mapping of the different Modbus addressing methods see Table 5-3: Mapping of Holding Registers, page 5-4.

Register assignment

Table 5-2: Modbus registers of the module

Address (hex.)	Access ro = read only rw = read/write	Description
0x0000 to 0x01FF	ro	Process data of inputs
0x0800 to 0x09FF	rw	Process data of outputs
0x1000 to 0x100B	ro	Module identifier
0x100C	ro	Module status see Register 100Ch: Module status
0x1010 - 0x1016	ro	reserved
0x1017	ro	Register mapping revision Register-mapping revision (always 2, if not, mapping is incompatible with this description)
0x1020	ro	Watchdog, actual time [ms]
0x1120	rw	Watchdog predefined time [ms] (default: 0) see Error behavior (watchdog) (page 5-10)
0x1130	rw	Modbus connection mode register, page 5-6
0x1131	rw	Modbus connection timeout in sec. (default: 0 = never). page 5-6
0x113C to 0x113D	rw	Modbus parameter restore, page 5-7 (reset of parameters to default values)
0x113E to 0x113F	rw	Modbus parameter save, page 5-7 (permanent storing of parameters)
0x1140	rw	Deactivate protocol Deactivates explicitly the selected Ethernet-protocol: Bit 0 = EtherNet/IP™ deactivated Bit 1 = Modbus TCP deactivated Bit 2 = PROFINET deactivated Bit 15 = web server deactivated
0x1141	ro	Active protocol Bit 0 = EtherNet/IP™ active Bit 1 = Modbus TCP active Bit 2 = PROFINET active Bit 15 = web server active
0x2400	ro	V1 [mV]: 0 at < 18 V
0x2401	ro	V2 [mV]: 0 at < 18 V
0x8000 to 0x8400	ro	Process data inputs
0x9000 to 0x9400	rw	Process data outputs
0xA000 to 0xA400	ro	Diagnostics

Table 5-2: Modbus registers of the module

Address (hex.)	Access ro = read only rw = read/write	Description
0xB000 to 0xB400	rw	Parameters

The following table shows the register mapping for the different Modbus addressing methods

Table 5-3: Mapping of Holding Registers

Description	Hex	Decimal	5-digit	Modicon
Inputs	0x0000 to 0x01FF	0 to 511	40001 to 40512	400001 to 400512
Outputs	0x0800 to 0x09FF	2048 to 2549	42049 to 42560	402049 to 402560
Module identifier	0x1000 to 0x1006	4096 to 4102	44097 to 44103	404097 to 404103
Module status	0x100C	4108	44109	404109
Watchdog, actual time	0x1020	4128	44129	404129
Watchdog, predefined time	0x1120	4384	44385	404385
Modbus connection mode register	0x1130	4400	44401	404401
Modbus connection timeout in sec.	0x1131	4401	44402	404402
Modbus parameter restore	0x113C to 0x113D	4412 to 4413	44413 to 44414	404413 to 404414
Modbus parameter save	0x113E to 0x113F	4414 to 4415	44415 to 44416	404415 to 404416
Deactivate protocol	0x1140	4416	44417	404417
Active protocol	0x1141	4417	44418	404418
V1 [mV]:	0x2400	9216	49217	409217
V2 [mV]:	0x2401	9217	49218	409218
Process data inputs	0x8000, 0x8001	32768 32769	-	432769 432770
Process data outputs	0x9000, 0x9001	36864, 36865	-	436865, 436866
Diagnostics	0xA000, 00A001	40960, 40961	-	440961, 440962

Table 5-3: Mapping of Holding Registers

Description	Hex	Decimal	5-digit	Modicon
Parameters	0xB000, 0xB001	45056, 45057	-	445057, 445058

Register 100Ch: Module status

This register contains a general module status.

Byte 1 (MSB)								Byte 0 (LSB)							
Bit 15	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**	**Bit 8**	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
-	FCE	-	-	-	-	V1	-	V2	-	-	-	-	-	-	DIAG

→ siehe auch:
chapter 4.7.3, Status- and control word (page 4-21)

Register 1130h: Modbus connection mode

This register defines the behavior of the Modbus connections:

Table 5-4: Register 1130h: Modbus connection mode

Bit	Name – Description
15 to 2	reserved
1	**MB_ImmediateWritePermission** – **0**: With the first write access, a write authorization for the respective Modbus-connection is requested. If this request fails, an exception response with exception-code 01h is generated. If the request is accepted, the write access is executed and the write authorization remains active until the connection is closed. – **1**: The write authorization for the respective Modbus-connection is already opened during the connection establishment. The first Modbus-connection thus receives the write authorization, all following connections don't (only if bit 0 = 1).
0	**MB_OnlyOneWritePermission** – **0**: all Modbus-connections receive the write authorization – **1**: Only one Modbus-connection can receive the write permission. A write permission is opened until a Disconnect. After the Disconnect the next connection which requests a write access receives the write authorization.

Register 1131h: Modbus Connection Timeout

This register defines after which time of inactivity a Modbus-connection is closed through a Disconnect.

Behavior of the BUS LED

In case of a Connection Timeout the BUS LED's behavior is as follows:

Connection-Time-out	BUS-LED
time-out	green, blinking

Register 0x113C and 0x113D: Restore Modbus-Connection-Parameters

Registers 0x113C and 0x113D serve for resetting the parameter-register 0x1120 and 0x1130 to 0x113B to the default settings.

For this purpose, write 0x6C6F to register 0×113C. To activate the reset of the registers, write "0×6164" ("load") within 30 seconds in register 0×113D.

Both registers can also be written with one single request using the function codes FC16 and FC23.

The service resets the parameters without saving them. This can be achieved by using a following "save" service.

Register 0x113E and 0x113F: Save Modbus-Connection-Parameters

Registers 0x113E and 0x113F are used for the non-volatile saving of parameters in registers 0x1120 and 0x1130 to 0x113B.

For this purpose, write 0x7361 to register 0×113E. To activate the saving of the registers, write "0×7665" ("save") within 30 seconds in register 0×113F.

Both registers can also be written with one single request using the function codes FC16 and FC23.

5.2 Data width of the TBEN-S2-4IOL in the Modbus-register area

Table 5-5: Data width of the modules

Module	Process input data	Process output data	Alignment
TBEN-S2-4IOL	208 byte	130 byte	word by word

5.3 Register mapping TBEN-S2-4IOL

Register	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	MSB								LSB							
	Input data															
0x0000 to 0x00xx	Process input data (see chapter 4 Process input data (page 4-6))															
	Module status															
0x00xx + 1 reg.	(see Register 100Ch: Module status (page 5-6))															
	Output data															
0x0800 to 0x08xx	process output data (see chapter 4, Process input data (page 4-6))															
	Diagnose															
	DXP-channel diagnostics															
0xA000	(see Diagnostic data (page 4-17))															
	IO-Link channel diagnostics															
0xA001 0xA002 0xA003 0xA004	(see Diagnostic data (page 4-17))															
	Parameters (see chapter 4, Parameters (page 4-9))															
	IO-Link port 1															
0xB000	-								SRO8	-	SRO6	-	SRO4	-	SRO2	-
0xB001	-								EN DO8	-	EN DO6	-	EN DO4	-	EN DO2	-
0xB002	Cycle time								GSD	Quick Start-Up	Data storage mode		Mode			
0xB003	-								Process output data mapping		Process input data mapping		Deactivate diagnostics		Proc. input data valid	Revi-sion
0xB004	**Vendor ID**															
0xB006 + 0xB007	**Device ID**															
0xB008	-															
	I/O-Link port 2															
0xB009 - 0xB010	8 Register Parameterdaten, Belegung analog zu Port 1															
	I/O-Link port 3															
0xB011- 0xB018	8 Register Parameterdaten, Belegung analog zu Port 1															
	I/O-Link port 4															
0xB019- 0xB020	8 Register Parameterdaten, Belegung analog zu Port 1															

5.4 Error behavior (watchdog)

5.4.1 Behavior of outputs

In case of a failure of the Modbus communication, the outputs' behavior is as follows, depending on the defined time for the Watchdog (register 0x1120, page 5-3):

- Watchdog = 0 ms (default)
  → outputs hold the momentary value in case of an error
- Watchdog > 0 ms
  → outputs switch to **0** after the watchdog time has expired (setting in register 0×1120).

NOTE

Setting the outputs to predefined substitute values is not possible in Modbus TCP. Eventually parameterized substitute values will not be used.

5.4.2 Behavior of the BUS LED

If the Watchdog has tripped, the BUS LED behaves as follows:

Watchdog	BUS-LED
tripped	constantly red

5.5 Parameters and diagnostic messages of the I/O channels

NOTE

Please find explanations regarding parameters and diagnostic messages in the section Register mapping TBEN-S2-4IOL (page 5-9).

6 EtherNet/IP™

6.1 EDS-file

The actual EDS-files for the TBEN-S can be downloaded from the TURCK-home page www.turck.com.

Table 6-1: Designation of the EDS-files

EDS-file	ZIP-file
TBEN-S2-4IOL_EDS_File_Rx.x.edsx	TBEN-S_ETHERNETIP.zip

6.2 QC - QuickConnect

QuickConnect is not supported by TBEN-S2-4IOL.

NOTE

Further information about QuickConnect and the configuration options can be found in the user manual for the TBEN-S product family D301346 -
"TBEN-S-product family, digital and analog standard modules"

6.3 Diagnostic messages via the process data

The diagnostic messages of the IO-Link-channels are directly mapped into the process data (see Process data mapping TBEN-S2-4OIL (page 6-9).)

Additionally, the device's status word contains the module diagnostics:

Status word

→ see also
chapter 4.7.3, Status- and control word (page 4-21)
or
chapter 6.5.2, Gateway Class (VSC 100), Object instance 2, gateway instance (page 6-18)

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
-	FCE	-	-	-	-	V1	-	V2	-	-	-	-	-	-	DIAG

6.4 EtherNet/IP™-standard classes

The TBEN-S stations support the following EtherNet/IP™ standard classes in accordance with the CIP specification.

Table 6-2: EtherNet/IP™ standard classes

Class Code	Object name
01 (0x01)	Identity Object (0x01)
04 (0x04)	Assembly Object (0x04)
06 (0x06)	Connection Manager Object (0x06)
245 (0xF5)	TCP/IP Interface Object (0xF5)
246 (0xF6)	Ethernet Link Object (0xF6)

6.4.1 Identity Object (0x01)

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 2.1 by ODVA & ControlNet International Ltd. and adapted to TBEN-S.

Class attributes

Table 6-3: Class attributes

Attr. No.	Attribute name	Get/ Set	Type	Value
1 (0x01)	REVISION	G	UINT	1
2 (0x02)	MAX OBJECT INSTANCE	G	UINT	1
6 (0x06)	MAX CLASS ATTRIBUTE	G	UINT	7
7 (0x07)	MAX INSTANCE ATTRIBUTE	G	UINT	7

Instance attribute

Table 6-4: Instance attribute

Attr. No.	Attribute name	Get/ Set	Type	Description
1 (0x01)	VENDOR	G	UINT	Contains the vendor ID. TURCK = 48
2 (0x02)	PRODUCT TYPE	G	UINT	Shows the general product type. Communications Adapter 12_{dec} = 0x0C
3 (0x03)	PRODUCT CODE	G	UINT	Identifier for a specific product of a device type. default: 27247_{dec} = 6A6F
4 (0x04)	REVISION Major Minor	G	STRUCT OF: USINT USINT	Revision of the item the Identity Object is representing. 0x01 0x06
5 (0x05)	DEVICE STATUS	G	WORD	See Table 6-5: Device Status
6 (0x06)	SERIAL NUMBER	G	UDINT	Contains the ident-no. of the product (3 last bytes of the MAC-ID).
7 (0x07)	PRODUCT NAME LENGTH NAME	G	STRUCT OF: USINT STRING [13]	e. g.: TBEN-S1-8DXP

Device Status

Table 6-5: Device Status

Bit	Name	Definition
0 to 1	reserved	default = 0
2	Configured	TRUE = 1 → The application of the device has been configured (≠ default-settings).
3	reserved	default = 0
4 to 7	Extended Device Status	0011 = no I/O connection established 0110 = at least one I/O connection in run mode 0111 = at least one I/O connection established, all in IDLE mode All other settings = reserved
8 to 15	reserved	default = 0

Common services

Table 6-6: Common Services

Service code	Class	Instance	Service name
01 (0x01)	yes	yes	Get_Attribute_All Returns a predefined list of the object's attributes.
05 (0x05)	no	yes	Reset Starts the reset service for the device.
14 (0x0E)	yes	yes	Get_Attribute_Single Returns the contents of a specified attribute.
16 (0x10)	no	no	Set_Attribute_Single Modifies a single attribute.

6.4.2 Assembly Object (0x04)

Assembly Objects bind attributes of multiple objects to allow data to or from each object to be sent or received over a single connection.

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 2.1 by ODVA & ControlNet International Ltd. and adapted to TBEN-S.

Class attributes

Table 6-7: Class attributes

Attr. No.	Attribute name	Get/ Set	Type	Value
1 (0x01)	REVISION	G	UINT	2
2 (0x02)	MAX OBJECT INSTANCE	G	UINT	104

Instance attribute

Table 6-8: Instance attribute

Attr. No.	Attribute name	Get/ Set	Type	Description
3 (0x03)	DATA	S	ARRAY OF BYTE	
4 (0x04)	SIZE	G	UINT	Number of bytes in attr. 3 256 or variable

Common services

Table 6-9: Common Services

Service code	Class	Instance	Service name
01 (0x01)	yes	yes	Get_Attribute_All
14 (0x0E)	no	yes	Get_Attribute_Single

Configuration Assembly (Instance 106)

TBEN-S stations support Configuration Assembly. It enables an EDS-based configuration/parameterization of the devices in the PLC software (if supported by the PLC).

The Configuration Assembly contains:

10 byte (module configuration data)

+ **72 bytes** (parameter data)

Parameter data mapping TBEN-S2-4IOL

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Module configuration data								
0 to 9	Reserved							
Parameter data TBEN-S2-4IOL								
10	DXP 2 - SRO Manual output reset after overcurrent							
11	DXP 4 - SRO Manual output reset after overcurrent							
12	DXP 6 - SRO Manual output reset after overcurrent							
13	DXP 8 - SRO Manual output reset after overcurrent							
14	DXP 2 - **EN DO** Activate output							
15	DXP 4 - **EN DO** Activate output							
16	DXP 6 - **EN DO** Activate output							
17	DXP 8 - **EN DO** Activate output							
	IO-Link port1							
18	Mode							
19	Data storage mode							
20	Cycle time							
21	Revision							
22	Activate Quick Start-Up							
23	Device parameterization via GSD							
24	Process input data invalid							
25	Deactivate diagnostics							
26	Process input data mapping							
27	Process output data mapping							
28 - 29	Vendor ID							
30 - 33	Device ID							
24 - 39	**IO-Link port 2** (assignment acc. to bytes 8 - 23 for port 1)							
40 - 55	**IO-Link port 3** (assignment acc. to bytes 8 - 23 for port 1)							
56 - 70	**IO-Link port 4** (assignment acc. to bytes 8 - 23 for port 1)							

Process data instances

Instance 101

Contains the module's **input data** (static length 256 bytes).

2 Bytes status information (see page 4-21)

+ process data

Instance 102

Contains the module's **output data** (static length 256 bytes).

2 bytes control data (mapped, but not defined)

+ process data

Instance 103 and Instance 104

In- and output assembly instances with variable assembly sizes. The assembly size is pre-calculated to support the stations I/O-configuration, enabled diagnostics, etc.

The effective size of the Assembly Instance can be determined using the Assembly Object (instance 0×67, attribute 0x04):

- **Input data:**
  Input Assembly Instance: 103
  0 - 208 bytes
  default: 208 bytes
- **Output data:**
  Output Assembly Instance: 104
  0 - 132 bytes
  default: 132 bytes

Process data mapping TBEN-S2-4OIL

- Status word included,
  can be deactivated via Gateway Class (VSC 100), GW Status Word (page 6-18) and GW Control Word (page 6-18).

ATTENTION!

Activate/deactivate the Status and Control Word in EtherNet/IP™

Changes in the process data mapping

➤ Observe that activating/deactivating the Status and Control Word causes changes in the process data mapping.

→ Connection Manager Object (0x06) (page 6-10).

IN	**Bit 15**	**Bit 14**	**Bit 13**	**Bit 12**	**Bit 11**	**Bit 10**	**Bit 9**	**Bit 8**	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
Status	see Status- and control word															
	V2	-	-	-	-	-	-	Diag	-	FCE	-	-	-	-	V1	-
Input data	Process input data (see chapter 4 Process input data (page 4-6))															
OUT																
Output data	process output data (see chapter 4, Process output data (page 4-8))															

6.4.3 Connection Manager Object (0x06)

This object is used for connection and connectionless communications, including establishing connections across multiple subnets.

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 2.1 by ODVA & ControlNet International Ltd. and adapted to TBEN-S.

Common services

Table 6-10: Common Services

Service code	Class	Instance	Service name
84 (0x54)	no	yes	FWD_OPEN_CMD (Opens a connection)
78 (0x4E)	no	yes	FWD_CLOSE_CMD (Closes a connection)
82 (0x54)	no	yes	UNCONNECTED_SEND_CMD

6.4.4 TCP/IP Interface Object (0xF5)

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 1.1 by ODVA & ControlNet International Ltd. and adapted to TBEN-S.

Class attributes

Table 6-11: Class attributes

Attr. No.	Attribute name	**G**et/ **S**et	Type	Value
1 (0x01)	REVISION	G	UINT	1
2 (0x02)	MAX OBJECT INSTANCE	G	UINT	1
3 (0x03)	NUMBER OF INSTANCES	G	UINT	1
6 (0x06)	MAX CLASS IDENTIFIER	G	UINT	7
7 (0x07)	MAX INSTANCE ATTRIBUTE	G	UINT	6

Instance attribute

Table 6-12: Instance attribute

Attr. No.	Attribute name	Get/ Set	Type	Description
1 (0x01)	STATUS	G	DWORD	Interface status (see page 6-12, Table 6-14:Interface Status)
2 (0x02)	CONFIGURATION CAPABILITY	G	DWORD	Interface Capability Flag (see page 6-12, Table 6-15: Configuration Capability)
3 (0x03)	CONFIGURATION CONTROL	G/S	DWORD	Interface Control Flag (see page 6-12, Table 6-16: Configuration Control)
4 (0x04)	PHYSICAL LINK OBJECT	G	STRUCT	
	Path size		UINT	Number of 16 bit words: 0x02
	Path:		Padded EPATH	0x20, 0xF6, 0x24, 0x01
5 (0x05)	INTERFACE CONFIGURATION	G	Structure of:	TCP/IP Network Interface Configuration (see page 6-12)
	IP Address	G	UDINT	Actual IP address
	NETWORK MASK	G	UDINT	Actual network mask
	GATEWAY ADDR.	G	UDINT	Actual default gateway
	NAME SERVER	G	UDINT	0 = no server address configured
	NAME SERVER 2		UDINT	0 = no secondary server address configured
	DOMAIN NAME	G	UDINT	0 = no Domain Name configured
6 (0x06)	HOST NAME	G	STRING	0 = no Host Name configured (see page 6-13)
12 (0x0C)	Quick Connect	G/S	BOOL	0 = deactivate 1 = activate

Common Services

Table 6-13: Common Services

Service code	Class	Instance	Service name
01 (0x01)	yes	yes	Get_Attribute_All
02 (0x02)	no	no	Set_Attribute_All
14 (0x0E)	yes	yes	Get_Attribute_Single
16 (0x10)	no	yes	Set_Attribute_Single

Interface Status

The Status attribute indicates the status of the TCP/IP network interface.
Refer to the state diagram,Figure 6-1: TCP/IP object state diagram (acc. to CIP Spec., Vol.2, Rev. 1.1) for a description of object states as they relate to the Status attribute.

Table 6-14: Interface Status

Bit(s)	Name	Definition
0-3	Interface Configuration Status	Indicates the status of the Interface Configuration attribute: 0 = The Interface Configuration attribute has not been configured 1 = The Interface Configuration attribute contains valid configuration. 2 to 15: reserved
4 to 31	reserved	

Configuration Capability

The Configuration Capability indicates the device's support for optional network configuration capability.

Table 6-15: Configuration Capability

Bit(s)	Name	Definition	Value
0	BOOTP Client	The device is capable of obtaining its network configuration via BOOTP.	1
1	DNS Client	The device is capable of resolving host names by querying a DNS server.	0
2	DHCP Client	The device is capable of obtaining its network configuration via DHCP.	1

Configuration Control

The Configuration Control attribute is used to control network configuration options.

Table 6-16: Configuration Control

Bit(s)	Name	Definition
0-3	Startup-configuration	Determines how the device shall obtain its initial configuration. 0 = The device shall use the interface configuration values previously stored (for example, in non-volatile memory or via hardware switches, etc). 1 to 3: reserved
4	DNS Enable	Always 0
5-31	reserved	Set to 0

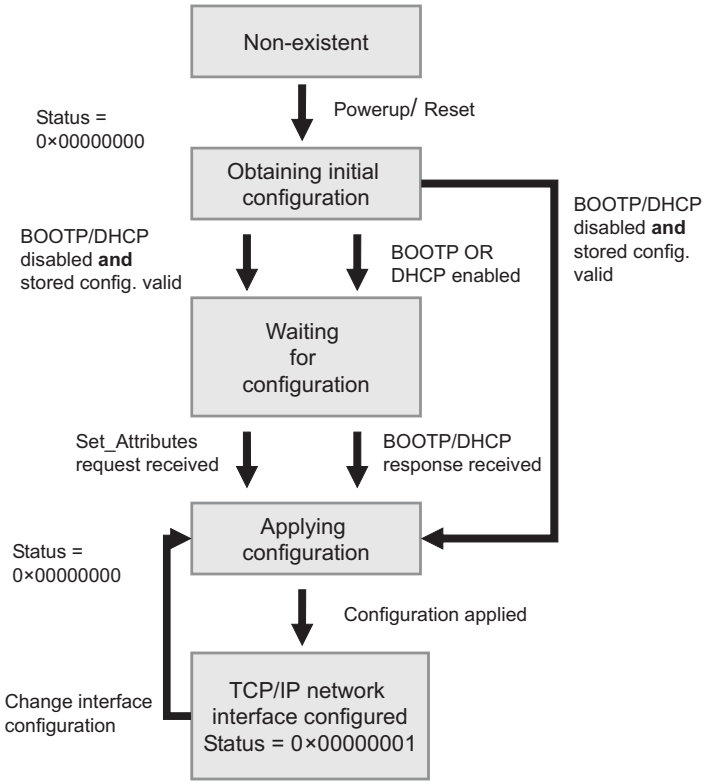
- Interface Configuration

This attribute contains the configuration parameters required to operate as a TCP/IP node. To modify the Interface Configuration attribute, get the Interface Configuration attribute first, change the desired parameters, then set the attribute.
The TCP/IP Interface Object applies the new configuration upon completion of the Set service. If the value of the Startup Configuration bits (Configuration Control attribute) is 0, the new configuration is stored in non-volatile memory.
The device does not reply to the set service until the values are safely stored to non-volatile memory.
An attempt to set any of the components of the Interface Configuration attribute to invalid values results in an error (status code 0x09) returned from the Set service.
If initial configuration is obtained via BOOTP or DHCP, the Interface Configuration attribute components are all 0 until the BOOTP or DHCP reply is received.
Upon receipt of the BOOTP or DHCP reply, the Interface Configuration attribute shows the configuration obtained via BOOTP/DHCP.

- Host Name

This attribute contains the device's host name.
The host name attribute is used when the device supports the DHCP-DNS Update capability and has been configured to use DHCP upon start up.
The mechanism allows the DHCP client to transmit its host name to the DHCP server. The DHCP server then updates the DNS records on behalf of the client.

Figure 6-1: TCP/IP object state diagram (acc. to CIP Spec., Vol.2, Rev. 1.1)



6.4.5 Ethernet Link Object (0xF6)

The following description of the Ethernet Link Object is taken from the CIP specification, Vol. 2, Rev. 1.1 by ODVA & ControlNet International Ltd. and adapted to TBEN-S.

Class attributes

Table 6-17: Class attributes

Attr. No.	Attribute name	Get/ Set	Type	Value
1 (0x01)	REVISION	G	UINT	1
2 (0x02)	MAX OBJECT INSTANCE	G	UINT	1
3 (0x03)	NUMBER OF INSTANCES	G	UINT	1
6 (0x06)	MAX CLASS IDENTIFIER	G	UINT	7
7 (0x07)	MAX INSTANCE ATTRIBUTE	G	UINT	6

Instance attribute

Table 6-18: Instance attribute

Attr. No.	Attribute name	Get/ Set	Type	Description
1 (0x01)	INTERFACE SPEED	G	UDINT	Speed in megabits per second (e. g. 10, 100, 1000, etc.)
2 (0x02)	INTERFACE FLAGS	G	DWORD	see Table 6-19: Interface Flags
3 (0x03)	PHYSICAL ADDRESS	G	ARRAY OF USINT	Contains the interface's MAC address (TURCK: 00:07:46:xx:xx:xx)
6 (0x06)	INTERFACE CONTROL		2 WORD	Allows port-wise changes of the Ethernet-settings
7 (0x07)	INTERFACE TYPE			
10 (0x0A)	INTERFACE LABEL			

Interface flags

Table 6-19: Interface Flags

Bits	Name	Definition	Default value
0	Link Status	Indicates whether or not the Ethernet 802.3 communications interface is connected to an active network. 0 = inactive link 1 = active link	Depends on application
1	Half/full duplex	0 = half duplex 1 = full duplex If the Link Status flag is 0, the value of the Half/Full Duplex flag is indeterminated.	Depends on application

Table 6-19: Interface Flags

Bits	Name	Definition	Default value
2 to 4	Negotiation Status	Indicates the status of the automatic duplex detection (autonegotiation) 0 = autonegotiation in progress 1 = autonegotiation and speed detection failed. Using default values for speed and duplex (10Mbps/half duplex). 2 = autonegotiation failed but detected speed (default: half duplex). 3 = successfully negotiated speed and duplex. 4 = autonegotiation not attempted. Forced speed and duplex.	Depends on application
5	Manual Setting Requires Reset	0 = interface can activate changes to link parameters (auto-negotiate, duplex mode, interface speed) automatically 1 = device requires a Reset service to be issued to its Identity Object in order to adapt the changes	0
6	Local Hardware Fault	0 = interface detects no local hardware fault 1 = a local hardware fault is detected	0

Common services

Table 6-20: Common Services

Service code	Class	Instance	Service name
01 (0x01)	yes	yes	Get_Attribute_All
14 (0x0E)	yes	yes	Get_Attribute_Single
76 (0x4C)	no	yes	Enetlink_Get_and_Clear

6.5 VSC-Vendor Specific Classes

In addition to supporting the above named CIP Standard Classes, the TBEN-S stations support the vendor specific classes described in the following.

Table 6-21: VSC-Vendor Specific Classes

Class Code dec. (hex.)	Name	Description
100 (64h)	Gateway Class, page 6-17	Contains data and settings concerning the field bus-specific part of the TBEN-S stations.
126 (1Ah)	Miscellaneous Parameters Class, page 6-20	Describes the EtherNet/IP™-Port properties
135 (87h)	DXP Class, page 6-21	Describes the DXP-channel properties
137 (89h)	IO-Link-Port Class, page 6-23	Describes the IO-Link--channel properties

6.5.1 Class Instance of the VSCs

NOTE

The class instance attributes are the same for each Vendor Specific Class.

The class-specific Object Instances and the corresponding attributes are explained in the paragraphs for the different VSC.

The general VSC - class instance attributes are defined as follows.

Table 6-22: Class instance

Attr. No. dec. (hex.)	Attribute name	Get/ Set	Type	Description
100 (64h)	Class revision	G	UINT	Contains the revision number of the class (maj. rel. *1000 + min. rel.).
101 (65h)	Max. instance	G	USINT	Contains the number of the highest instance of an object created on this level in the class hierarchy.
102 (66h)	# of instances	G	USINT	Contains the number of Object Instances created in this class.
103 (67h)	Max. class attribute	G	USINT	Contains the number of the last class attribute to be implemented.

6.5.2 Gateway Class (VSC 100)

This class contains all information which concerning the whole module not the different I/O channels.

Class instance

NOTE

Please refer to section Class Instance of the VSCs (page 6-16) for the description of the class instance for the VSC.

Object instance 1, boot instance

Table 6-23: Object instance 1, boot instance

Attr. No. dec. (hex.)	Attribute name	Get/ Set	Type	Description
100 (64h)	Max object attribute	G	USINT	Contains the number of the last object attribute to be implemented.
101 (65h)	Hardware revision	G	STRUCT	Contains the hardware revision number of the module (USINT Maj./USINT Min.)
102 (66h)	Firmware revision	G	STRUCT	Contains the revision number of the boot firmware (Maj./Min.).
103 (67h)	Service tool ident number	G	UDINT	Contains the BOOT ID number that serves as an identification number for the DTM-software.
104 (68h)	Hardware Info	G	STRUCT	Contains station hardware information (UINT): – count (number of the following entries) – CLOCK FREQUENCY (kHz) – MAIN FLASH (in kB) – MAIN FLASH SPEED (ns) – SECOND FLASH (kB) – RAM (kB), – RAM SPEED (ns), – RAM data WIDTH (bit), – SERIAL EEPRPOM (kbit) – RTC SUPPORT (in #) – AUTO SERVICE BSL SUPPORT (BOOL) – HDW SYSTEM

Object instance 2, gateway instance

Table 6-24: Object instance 2, gateway instance

Attr. No. dec. (hex.)	Attribute name	Get/ Set	Type	Description
109 (6Dh)	Status word (Status register 2)	G	STRUCT	The Status Word contains general module status information **Module** – Bit 15: reserved – Bit 14: Force Mode active, „Force Mode Active Error“ (FCE) The Force Mode is activated, no access to the module possible because there is already a connection to the DTM. – Bit 13: reserved – Bit 12: reserved **Internal bus** – Bit 11: reserved – Bit 10: reserved **Voltage errors** – Bit 09: "V1 too low" (< 18 VDC). – Bit 08: reserved – Bit 07: "V2 too low" (< 14 VDC). – Bit 06: reserved – Bit 05: reserved – Bit 04: reserved **Warnings** – Bit 03: reserved – Bit 02: reserved – Bit 01: reserved – Bit 00: At least one I/O-channel sends active diagnostics.
115 (73h)	ON IO CONNECTION TIMEOUT	G/S	ENUM USINT	Reaction to the I/O connection exceeding the time limit. SWITCH IO FAULTED (0): The channels are switched to substitute value. SWITCH IO OFF (1): The outputs are switched to 0. SWITCH IO HOLD (2): No further changes to the I/O-data. The outputs are held.
138 (0x8A)	GW Status Word	Get/ Set	DWORD	Activates or deactivates the mapping of the status word into the module's input data.
139 (0x8B)	GW Control Word	Get/ Set	DWORD	Activates or deactivates the mapping of the control word into the module's output data.

Table 6-24: Object instance 2, gateway instance

Attr. No. dec. (hex.)	Attribute name	Get/ Set	Type	Description
140 (0x8C)	Disable Protocols	Get/ Set	UINT	Deactivation of the used Ethernet protocol. bit assignment 1 = Modbus/TCP 2 = PROFINET 11 to 14: reserved 15 = web server

Object instance 4, COS/CYCLIC instance

Table 6-25: Object instance 4, COS/CYCLIC instance

Attr. No. dec. (hex.)	Attribute name	Get/ Set	Type	Description
104 (64h)	COS data mapping	G/S	ENUM USINT	The actual data are loaded to the non-volatile memory of the station. Changes become valid after a start-up! 0 = standard: Data of COS message → input data. 1 = process input data (only the process data input image is transferred to scanner) 2 to 7: reserved

6.5.3 Miscellaneous Parameters Class (VSC 126)

Ethernet-Port ETH 1 = instance 1

Ethernet-Port ETH 2 = instance 2

Table 6-26: Object instance

Attr. No. dec. (hex.)	Attribute name	Get/ Set	Type	Description
109 (64h)	Ethernet port Parameters	G/S	DWORD	0 = autonegotiate, AutoMDIX 1 = 100BaseT, full duplex, linear topology (AutoMDIX disabled) 2 = 100BaseT, full duplex, linear topology (AutoMDIX disabled) 3 = 100BaseT, full duplex, linear topology (AutoMDIX disabled) 4 = 100BaseT, full duplex, linear topology (AutoMDIX disabled)
112 (70h)	I/O controller Software revision	G	DWORD	The number of instances of this parameter depends on the number of I/O controllers.

6.5.4 DXP Class 135 (87h)

This class provides one single instance for all DXP-channels.

DXP2, DXP4, DXP6, DXP 8
Digital inputs at **PIN 2** of the M12-ports

DXP1, DXP3, DXP5, DXP7
Digital inputs at **PIN 4** of the M12-ports
The IO-Link-channel is parameterized as DI.

Table 6-27: Object instance

Attr. No. dec. (hex.)	Attribute name	Get/Set	Type	Description
DXP-channel (pin 2)				
1 (01h)	DXP 2 - Manual output reset after overcurrent	G/S	USINT	0 = no 1 = yes
2 (02h)	DXP 4 - Manual output reset after overcurrent	G/S	USINT	0 = no 1 = yes
3 (03h)	DXP 6 - Manual output reset after overcurrent	G/S	USINT	0 = no 1 = yes
4 (04h)	DXP 8 - Manual output reset after overcurrent	G/S	USINT	0 = no 1 = yes
5 (05h)	DXP 2 - Activate output	G/S	USINT	0 = no 1 = yes
6 (05h)	DXP 4 - Activate output	G/S	USINT	0 = no 1 = yes
7 (05h)	DXP 6 - Activate output	G/S	USINT	0 = no 1 = yes
8 (05h)	DXP 8 - Activate output	G/S	USINT	0 = no 1 = yes
9 (05h)	DXP 2 - Overcurrent output	G	USINT	0 = inactive 1 = active
10 (0Ah)	DXP 4 - Overcurrent output	G	USINT	0 = inactive 1 = active
11 (0Bh)	DXP 6 - Overcurrent output	G	USINT	0 = inactive 1 = active
12 (0Ch)	DXP 8 - Overcurrent output	G	USINT	0 = inactive 1 = active
21 (05h)	DXP 2 - input	G	USINT	0 1
22 (16h)	DXP 4 - input	G	USINT	0 1

Table 6-27: Object instance

Attr. No. dec. (hex.)	Attribute name	Get/Set	Type	Description
23 (17h)	DXP 6 - input	G	USINT	0 1
24 (18h)	DXP 8 - input	G	USINT	0 1
25 (19h)	DXP 2 - output	G	USINT	0 1
26 (1Ah)	DXP 4 - output	G	USINT	0 1
27 (1Bh)	DXP 6 - output	G	USINT	0 1
28 (1Ch)	DXP 8 - output	G	USINT	0 1
IO-Link-channel: parameterized as DI (pin 4)				
13 (0Dh)	DXP 1 - input	G	USINT	0 1
14 (0Eh)	DXP 3 - input	G	USINT	0 1
15 (0Fh)	DXP 5 - input	G	USINT	0 1
16 (10h)	DXP 7 - input	G	USINT	0 1
17 (11h)	DXP 1 - Input value valid (Data Valid Signal)	G	USINT	0 = no 1 = yes
18 (12h)	DXP 3 - Input value valid (Data Valid Signal)	G	USINT	0 = no 1 = yes
19 (13h)	DXP 5 - Input value valid (Data Valid Signal)	G	USINT	0 = no 1 = yes
20 (14h)	DXP 7 - Input value valid (Data Valid Signal)	G	USINT	0 = no 1 = yes

6.5.5 IO-Link Port Class 137 (89h)

This class contains 4 object instance, one for each IO-Link-port.

Table 6-28: Object instance 1 - 4

Attr. No. dec. (hex.)	Attribute name	Get/Set	Type	Description
1 (01h)	IO-Link port x - operation mode	G/S	USINT	0 = IO-Link without validation 1 = IO-Link with family compatible device 2 = IO-Link with compatible device 3 = IO-Link with identical device 4 = DI (with parameter access) 5 to 7: reserved 8 = DI
2 (02h)	IO-Link port x - data storage mode	G/S	USINT	0 = activated 1 = overwrite 2 = read in 3 = deactivated, clear
3 (03h)	IO-Link port x - cycle time	G/S	USINT	0 = automatic 16 = 1,6 ms 32 = 3,2 ms 48 = 4,8 ms 64 = 6,4 ms 68 = 8,0 ms 72 = 9,6 ms 76 = 11,2 ms 80 = 12,8 ms 84 = 14,4 ms 88 = 16,0 ms 92 = 17,6 ms 96 = 19,2 ms 100 = 20,8 ms 104 = 22,4 ms 108 = 24,0 ms 112 = 25,6 ms 116 = 27,2 ms 120 = 28,8 ms 124 = 30,4 ms 128 = 32,0 ms 129 = 33,6 ms 130 = 36,8 ms 132 = 40,0 ms 134 = 41,6 ms 135 = 43,2 ms 136 = 44,8 ms 137 = 46,4 ms 138 = 48,0 ms 139 = 49,6 ms 140 = 51,2 ms 141 = 52,8 ms 142 = 54,4 ms 143 = 56,0 ms 144 = 57,6 ms 145 = 59,2 ms 146 = 60,8 ms 147 = 62,4 ms 148 = 64,0 ms 149 = 65,6 ms 150 = 67,2 ms 151 = 68,8 ms 152 = 70,4 ms 153 = 72,0 ms 154 = 73,6 ms 155 = 75,2 ms 156 = 76,8 ms 157 = 78,4 ms 158 = 80,0 ms 159 = 81,6 ms 160 = 83,2 ms 161 = 84,8 ms 162 = 86,4 ms 163 = 88,0 ms 164 = 89,6 ms 165 = 91,2 ms 166 = 92,8 ms 167 = 94,4 ms 168 = 96,0 ms 169 = 97,6 ms 170 = 99,2 ms 171 = 100,8 ms 172 = 102,4 ms 173 = 104,0 ms 174 = 105,6 ms 175 = 107,2 ms

Table 6-28: Object instance 1 - 4

Attr. No. dec. (hex.)	Attribute name	Get/Set	Type	Description
3 (03h)	IO-Link port x - cycle time (continuation)	G/S	USINT	176 = 108,8 ms 177 = 110,4 ms 178 = 112,0 ms 179 = 113,6 ms 180 = 115,2 ms 181 = 116,8 ms 182 = 118,4 ms 189 = 129,6 ms 190 = 131,2 ms 191 = 132,8 ms
4 (04h)	IO-Link port x - revision	G/S	USINT	0 = automatic 1 = V 1.0
5 (05h)	IO-Link port x - Quick Start-Up activate	G/S	USINT	0 = no 1 = yes
6 (06h)	IO-Link port x - device parameterization via GSD	G/S	USINT	0 = no 1 = yes
7 (07h)	IO-Link port x - process input data invalid	G/S	USINT	0 = diagnostic generated 1 = no diagnostic generated
8 (08h)	IO-Link port x - deactivate diagnostics	G/S	USINT	0 = no 1 = notifications 2 = notifications and warnings 3 = yes
9 (05h)	IO-Link port x - Process input data mapping	G/S	USINT	0 = direct 1 = swap 16 bit 2 = swap 32 bit 3 = swap all
10 (0Ah)	IO-Link port x - Process output data mapping	G/S	USINT	0 = direct 1 = swap 16 bit 2 = swap 32 bit 3 = swap all
11 (0Bh)	IO-Link port x - Vendor ID	G/S	INT	0 = inactive 1 = active
12 (0Ch)	IO-Link port x - Device ID	G/S	DINT	0 = inactive 1 = active
13 (0Dh)	IO-Link port x - wrong or missing device	G	USINT	0 = inactive 1 = active
14 (0Eh)	IO-Link port x - data storage error	G	USINT	0 = inactive 1 = active

Table 6-28: Object instance 1 - 4

Attr. No. dec. (hex.)	Attribute name	Get/Set	Type	Description	
15 (0Fh)	IO-Link port x - process input data invalid	G	USINT	0 = inactive 1 = active	
16 (10h)	IO-Link port x - hardware error	G	USINT	0 = inactive 1 = active	
17 (11h)	IO-Link port x - maintenance events	G	USINT	0 = inactive 1 = active	
18 (12h)	IO-Link port x - out-of-specification events	G	USINT	0 = inactive 1 = active	
19 (13h)	IO-Link port x - parameterization error	G	USINT	0 = inactive 1 = active	
20 (14h)	IO-Link port x - over temperature	G	USINT	0 = inactive 1 = active	
21 (05h)	IO-Link port x - lower limit value underrun	G	USINT	0 = inactive 1 = active	
22 (16h)	IO-Link port x - upper limit value exceeded	G	USINT	0 = inactive 1 = active	
23 (17h)	IO-Link port x - under voltage	G	USINT	0 = inactive 1 = active	
24 (18h)	IO-Link port x - over voltage	G	USINT	0 = inactive 1 = active	
25 (19h)	IO-Link port x - overload	G	USINT	0 = inactive 1 = active	
26 (1Ah)	IO-Link port x - common error	G	USINT	0 = inactive 1 = active	
27 (1Bh)	IO-Link port x - port parameterization error	G	USINT	0 = inactive 1 = active	
Input data					
28 (1Ch)	IO-Link port x - input data word 0	G	USINT		
...	...	G	USINT		
43 (2Bh)	IO-Link port x - input data word 15	G	USINT		

Table 6-28: Object instance 1 - 4

Attr. No. dec. (hex.)	Attribute name	Get/Set	Type	Description	
Output data					
44 (2Ch)	IO-Link port x - output data word 0	G	USINT		
...	...	G	USINT		
59 (3Bh)	IO-Link port x - output data word 15	G	USINT		

7 PROFINET

7.1 GSDML-file

The actual GSDML-file for TBEN-S can be downloaded from the TURCK-home page www.turck.com.

Table 7-1: Designation of the GSDML-files

Install GSDML file	Zip-file
GSDML-Vx.x-TURCK-TBEN_S2_4IOL-YYYYMMDD-xxxxxx.xml	TBEN-S_PROFINET.zip

7.2 Configuration TBEN-S2-4IOL

The TBEN-S2-4IOL provide 4 parameterizable I(O-Link-channels and 4 universal I/O-channels (DXP).

In addition to that, 3 virtual channels are provided via GSDML in PROFINET. Those channels are used to map the different diagnostic and status (IO-Link and DXP-diagnostics (see Diagnostic data (page 4-17)), IO-Link-Events (see Subindex 65: IO-Link Events (page 4-26), module status (see Status- and control word (page 4-21)) data into the master's process image.
Further information can be found in chapter 9, Configuration in HW-Config (page 9-3).

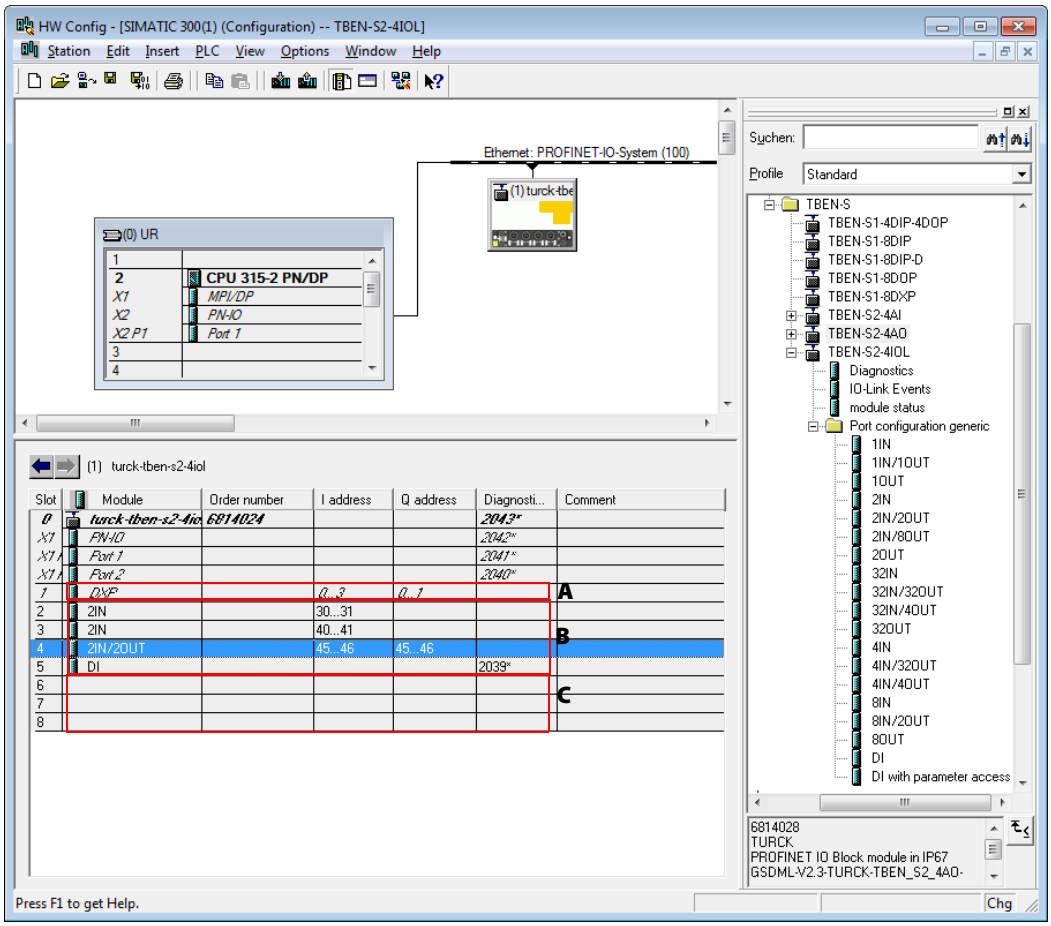


Figure 7-1: Example of a module configuration (in STEP7)

A *DXP-channels*
B *IO-Link ports (slots 2- 5)*
C *one channel each for diagnostics and status (slots 6 - 8)*

7.3 FSU - Fast Start-Up (prioritized startup)

FSU - Fast Start-Up is not supported by TBEN-S2-4IOL.

NOTE

Further information about FSU - Fast Start-Up and the configuration options can be found in the user manual for the TBEN-S product family D301346 -
"TBEN-S-product family, digital and analog standard modules"

7.4 PROFINET-diagnostics - TBEN-S2-4IOL

Module diagnostics (slot 0 **A**)			**PROFINET-diagnostics**		
Diagnosis	**Channel**	**Connector**	**Error code**	**Channel**	**Slot**
undervoltage					
V1	0.0		0x0002	0	
V2	0.1		0x0002	1	

I/O-diagnostics (slot 1 to 4)			**PROFINET-diagnostics**		
DXP-diagnostics	**Channel**		**Error Code**	**Channel**	
Overcurrent output	DXP 5	C1	0x0004	2	1
	DXP 6	C2	0x0004	4	1
	DXP 7	C3	0x0004	6	1
	DXP 8	C4	0x0004	8	1
IO-Link-diagnostics					
Port 1					
Undervoltage (VLOW)	IOL1	C1	0x0002	1	2
Overvoltage (VHIGH)			0x0003		
Overload (OVL)			0x0004		
Overtemperature (OTMP)			0x0005		
Wrong or missing device (CFGERR)			0x0006		
Upper limit value exceeded (ULVE)			0x0007		
Lower limit value underrun (LLVU)			0x0008		
Data storage error (DSER)			0x0009		
Process input data invalid (PDINV)					
Maintenance events (EVT1)					
Out of specification error (EVT2)					
Port parameterization error (PPE)			0x0010		
Parameterization error (PRMER)					
Hardware error (HWER)			0x0010		
Port 2					
similar to port 1	IOL2	C2		3	3
Port 3					
similar to port 1	IOL3	C3		5	4
Port 4					
similar to port 1	IOL4	C4		7	5

A *Slot in configuration tool (e.g. Siemens HW Config)*

7.5 Parameters

Two types of parameters have to be distinguished for the TBEN-S stations, the PROFINET parameters of a station and the specific parameters of the I/O-channels.

7.5.1 General module parameters

Table 7-2: Parameters for the station

A *Default setting*

Parameter name	Value	Meaning
Output behavior at communication loss	00 = set to 0 **A**	The station switches the outputs to "0". No error information is transmitted.
	10 = keep last value	The station maintains the actual output data.
Deactivate all diagnostics	0 = no **A**	Diagnostic messages and alarms are generated.
	1 = yes	Diagnostic messages and alarms are generated.
Deactivate load voltage diagnostics	0 = no **A**	Monitoring of voltage V2 is activated.
	1 = yes	An under voltage at V2 is not monitored.
Deactivate I/O-ASSISTANT Force Mode Force Mode	0 = no **A**	The single field bus protocols can be deactivated.
	1 = yes	
Deactivate EtherNet/IP™	0 = no **A**	
	1 = yes	
Deactivate Modbus TCP	0 = no **A**	
	1 = yes	
Deactivate WEB server	0 = no **A**	
	1 = yes	

7.5.2 Parameters for I/O channels

see Parameters (page 4-9)

7.6 Description of user data for acyclic services

The acyclic data exchange is done via Record Data CRs (CR→ Communication Relation).

Via these Record Data CRs the reading and writing of the following services is realized:

- Writing of AR data
- Writing of configuration data
- Reading and writing of device data
- Reading of diagnostic data
- Reading of I/O data
- Reading of Identification Data Objects (I&M functions)

7.6.1 Description of the acyclic device user data

Table 7-3: Module Application Instance

Index (dec.)	Name	Data type	r/w	Comment
1	Module parameters	WORD	r/w	Parameter data of the module (slot 0)
2	Module designation	STRING	r	Designation assigned to the module.
3	Module revision	STRING	r	Firmware revision of the module
4	Vendor ID	WORD	r	Ident no. TURCK
5	Module name	STRING	r	The device name assigned to the module
6	Module type	STRING	r	Module type
7	Device-ID	WORD	r	Ident no. od the module
8 to 23	reserved			
24	Module diagnostics	WORD	r	Diagnostic data of the module (slot 0).
25 to 31	reserved			
32	Input list	Array of BYTE	r	List of all input channels in the module
33	Module output list	Array of BYTE	r	List of all output channels in the module
34	Diag. list	Array of BYTE	r	List of all I/O-channel diagnostics
35 (0x23)	Parameter list	Array of BYTE	r	List of all I/O-channel parameters
36 to 45039	reserved			

Table 7-3: Module Application Instance

Index (dec.)	Name	Data type	r/w	Comment
45040 (0xAFF0)	I&M0-functions		r	Identification & Maintaining services
45041 (0xAFF1)	I&M1-functions	STRING [54]	r/w	I&M tag Function and location
45042 (0xAFF2)	I&M2-functions	STRING [16]	r/w	I&M tag Function and location
45043 (0xAFF3)	I&M3-functions	STRING [54]		
45044 (0xAFF4)	I&M4-functions	STRING [54]		
45045 (0xAFF5) to 45055 (0xAFFF)	I&M5 to I&M15-functions			not supported
0x7000	Module parameters	WORD	r/w	Activate active field bus protocol

7.6.2 Description of the acyclic I/O-channel user data

Table 7-4: I/O-channel user data

Index (dec.)	Name	Data type	r/w	Comment
1	Module parameters	specific	r/w	Parameters of the module
2	Module type	ENUM UINT8	r	Contains the module type
3	Module version	UINT8	r	Firmware version of the I/O-channels
4	Module ID	DWORD	r	Ident number of the I/Os
5 to 9	reserved			
10	Slave controller version	UINT8 array [8]	r	Version no. of the slave controller
11 to 18	reserved			
19	Input data	specific	r	Input data of the respective I/O channel
20 to 22	reserved			
23	Output data	specific	r/w	Output data of the respective I/O channel
...	reserved			

Table 7-4: I/O-channel user data

Index (dec.)	Name	Data type	r/w	Comment
251	CAP 1	Record	r/w	Client access point for Class 1 Master
252	CAP 2	Record	r/w	
253	CAP 3	Record	r/w	
254	CAP 4	Record	r/w	
255	CAP 5	Record	r/w	Client access point for Class 2 Master
256	CAP 6	Record	r/w	
257	CAP 7	Record	r/w	
258	CAP 8	Record	r/w	

7.6.3 IM99 (IOL_M)

Table 7-5: IM99 (IOL_M)

Name	Size	Data type	Default setting
IOL_LINK_VERSION	1 byte	UINT8	11h
IO_LINK_PROFILE_VERSION	1 byte	UINT8	0
IO_LINK_FEATURE_SUPPORT	4 bytes	UINT32	0
NUMBER_OF_PORTS	1 byte	UINT8	4
REF_PORT_CONFIG	1 byte	UINT8	0
REF_IO_MAPPING	1 byte	UINT8	0
REF_IOL_M	1 byte	UINT8	0
NUMBER_OF_CAP	1 byte	UINT8	5
INDEX_CAP1	1 byte	UINT8	251
INDEX_CAP2	1 byte	UINT8	252
INDEX_CAP3	1 byte	UINT8	253
INDEX_CAP4	1 byte	UINT8	254
INDEX_CAP5	1 byte	UINT8	255

8 The IO-Link function block IOL_CALL

8.1 General

The IO-Link function block IOL_CALL is specified in the IO-Link specification "IO-Link Integration Part 1-Technical Specification for PROFIBUS and PROFINET"".

NOTE

Depending on the PLC manufacturer, the IO-Link CALL function block can differ from the specification (for example in the representation or the use of variables).

8.2 IOL_CALL in accordance with IO-Link specification

The following figure shows the function block as it is defined in the specification:

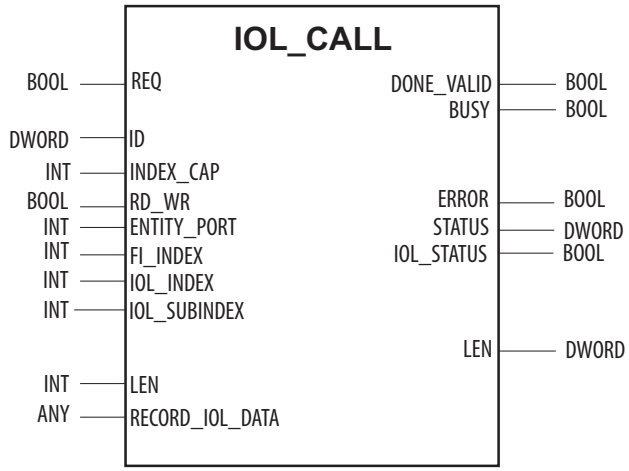


Figure 8-1: IOL_CALL in accordance with IO-Link specification

8.2.1 Input variables

The following description of the function block variables is partially taken from this IO-Link specification.

Table 8-1: Input variables

Name		
IO-Link Spec.	**Data Type**	**Meaning**
REQ	BOOL	A rising edge triggers the send command.
ID	DWORD	Address of the IO-Link master module – PROFIBUS/PROFINET (Siemens): Start address of the input data of the IO-Link master module.
INDEX_CAP	INT	Function block instance: 251 to 254
RD_WR	BOOL	0 = read access 1 = write access
ENTITY_PORT	INT	Address of the IO-Link port to be accessed.
FI_INDEX	INT	Fix value (65098): defines the access as IO-Link CALL
IOL_INDEX	INT	Number of the IO-Link index which has to be written or read.
IOL_SUBINDEX	INT	Definition of a possible sub index.
LEN	INT	Length of the data to be read/written. This information is not necessary for the Siemens IOL_-CALL (Integration of the IO-Link-Master in Step 7 (page 9-1)).
RECORD_IOL_DATA		Source/destination for the data to be read or written.

8.2.2 Output variables

The following description of the function block variables is partially taken from this IO-Link specification.

Table 8-2: Output variables

Name		
IO-Link Spec.	**Data Type**	**Meaning**
DONE_VALID	BOOL	The read or write access has been executed.
BUSY	BOOL	The read or write access is actually in progress.
ERROR	BOOL	Error while executing the read or write access.
STATUS	DWORD	Communication error status Status of the acyclic communication. → see STATUS - communication error status (page 8-5)
IOL_STATUS	DWORD	IO-Link error messages (in accordance with "IO-Link Integration Part 1- Technical Specification for PROFIBUS and PROFINET" and "IO-Link Interface and System"), which concern the communication between IO-Link master and connected devices. → see IOL_STATUS (page 8-7)
LEN	INT	Length of the data which were read.

8.2.3 STATUS - communication error status

The status of the acyclic communication contains 4 byte and is structured as follows:

Byte 3	Byte 2	Byte 1	Byte 0
Vendor specific identifier (not always applicable)	0×80 Specifies the error as an error of acyclic communication.	Error code → see Table 8-3: Status Codes	Vendor specific identifier (not always applicable)

Table 8-3: Status Codes

Status Code	Name	Meaning
0×FF000000	TIMEOUT	Internal error in the communication with the module
0×00FFFF00	INVALID_HANDLE	
0×00FFFE00	HANDLE_OUT_OF_BUFFERS	
0×00FFFD00	HANDLE_DESTINATION_UNAVAILABLE	
0×00FFFC00	HANDLE_UNKNOWN	
0×00FFFB00	HANDLE_METHOD_INVALID	
0×xx80A0xx	MASTER_READ_ERROR	Error reading
0×xx80A1xx	MASTER_WRITE_ERROR	Error writing
0×xx80A2xx	MASTER_MODULE_FAILURE	Failure of the IO-Link-Master, bus failure possible
0×xx80A6xx	MASTER_NO_DATA	No data received.
0×xx80A7xx	MASTER_BUSY	IO-Link-Master busy.
0×xx80A9xx	MASTER_FEATURE_NOT_SUPPORTED	Function not supported by IO-Link-Master.
0×xx80AAxx	MASTER_RESOURCE_UNAVAILABLE	IO-Link-Master not available.
0×xx80B0xx	ACCESS_INVALID_INDEX	Index invalid, wrong INDEX_CAP used
0×xx80B1xx	ACCESS_WRITE_LENGTH_ERROR	Length of data to be written can not be handled from the module, possible wrong module accessed.
0×xx80B2xx	ACCESS_INVALID_DESTINATION	Wrong slot accessed.
0×xx80B03xx	ACCESS_TYPE_CONFLICT	IOL_CALL invalid.
0×xx80B5xx	ACCESS_STATE_CONFLICT	Error in IOL_CALL sequence
0×xx80B6xx	ACCESS_DENIED	IOL-Link master module refuses the access.

Table 8-3: Status Codes

Status Code	Name	Meaning
0×xx80C2xx	RESOURCE_BUSY	The IO-Link master module is busy or is waiting for an answer of the connected IO-Link device.
0×xx80C3xx	RESOURCE_ UNAVAILABLE	
0×xx8901xx	INPUT_LEN_TOO_SHORT	The index to be read contains more data than defined in the input variable "LEN".

8.2.4 IOL_STATUS

The IOL_STATUS consists of 2 byte Error Code (IOL_M Error_Codes, according to "IO-Link Integration Part 1- Technical Specification for PROFIBUS and PROFINET") and 2 byte Error Type (according to "IO-Link Interface and System").

Byte 3	Byte 2	Byte 1	Byte 0
IOL_M Error_Codes → see Table 8-4: IOL-M Error Codes according to "IO-Link Integration Part 1- Technical Specification for PROFIBUS and PROFINET"		Error Types → see Table 8-5: IOL Error Types according to "IO-Link Interface and System"	

Table 8-4: IOL-M Error Codes

Error code	Name acc. to spec	Meaning
0×0000	No error	no error
0×7000	IOL_CALL conflict	Unexpected write-request, read request expected
0×7001	Wrong IOL_CALL	Decoding error
0×7002	Port blocked	The accessed port is occupied by another task.
...	reserved	-
0×8000	Timeout	Timeout, IOL master or IOL device port busy.
0×8001	Wrong index	Error: IOL index < 32767 or > 65535 selected.
0×8002	Wrong port address	Port address not available.
0×8003	Wrong port function	Port function not available.
...	reserved	-

Table 8-5: IOL Error Types

Error code	Name acc. to spec	Meaning
0×1000	COM_ERR	Communication error Possible sources: Possible cause: the addressed port is parameterized as DI and is not in IO-Link mode.
0×1100	I_SERVICE_TIMEOUT	Timeout in communication, Device does not respond in time.
0×5600	M_ISDU_CHECKSUM	Master reports checksum error, access to device not possible.
0×5700	M_ISDU_ILLEGAL	Device can not respond to master request.
0×8000	APP_DEV	Application error in the device
0×8011	IDX_NOTAVAIL	Index not available
0×8012	SUBIDX_NOTAVAIL	Sub index not available
0×8020	SERV_NOTAVAIL	Service temporarily not available
0×8021	SERV_NOTAVAIL_LOCCTRL	Service temporarily not available, device is busy (e. g. teaching or parameterization of the device at the device active).
0×8022	SERV_NOTAVAIL_DEVCTRL	Service temporarily not available, device is busy (e. g. teaching or parameterization of the device via DTM/ PLC etc. active).
0×8023	IDX_NOT_WRITEABLE	Access denied, index not writable
0×8030	PAR_VALOUTOFRNG	Parameter value out of range
0×8031	PAR_VALGTLIM	Parameter value above the upper limit
0×8032	PAR_VALLTLIM	Parameter value below the lower limit
0×8033	VAL_LENOVRRUN	Length of data to be written does not match the length defined for this parameter.
0×8034	VAL_LENUNDRUN	
0×8035	FUNC_NOTAVAIL	Function not available in the device
0×8036	FUNC_UNAVAILTEMP	Function temporarily not available in the device
0×8040	PARA_SETNVALID	Invalid parameter: Parameters not consistent with other parameters in the device.
0×8041	PARA_SETINCONSIST	Inconsistent parameters
0×8082	APP_DEVNOTRDY	Application not ready, device is busy
0×8100	UNSPECIFIC	Vendor specific, see device documentation
0×8101 to 0×80FF	VENDOR_SPECIFIC	

9 Integration of the IO-Link-Master in Step 7

9.1 Example project

9.1.1 Used hardware

- Siemens S7, CPU 315-2 PN/DP, 6ES7-2EH13-0AB0 with PROFINET
- TBEN-S2-4IOL
  with:
  - IO-Link port 1: TURCK temperature sensor,
    TS-530-LI2UPN8X-H1141-L016, IO-Link V1.0
  - IO-Link port 2: TURCK linear position sensor,
    Li200P0-Q25LM0-ELiUPN8X3-H1151, IO-Link V1.0
  - IO-Link port 3: TURCK IO-HUB,
    TBIL-M1-16DXP, IO-Link V1.1
  - IO-Link port 4: TURCK ultrasonic sensor,
    RU130U-M18E-LiU2PN8X2T-H1151, IO-Link V1.1

9.1.2 Used software

- SIMATIC Manager, Step 7, version 5.5, SP2

9.2 Configuration in HW-Config

9.2.1 Configuration of the IO-Link master

Install the GSDML-file of the IO-Link-Master and add it to the "PROFINET-IO-System (100)".

The TBEN-S2-4IOL appears as a modular slave with 8 virtual slots.

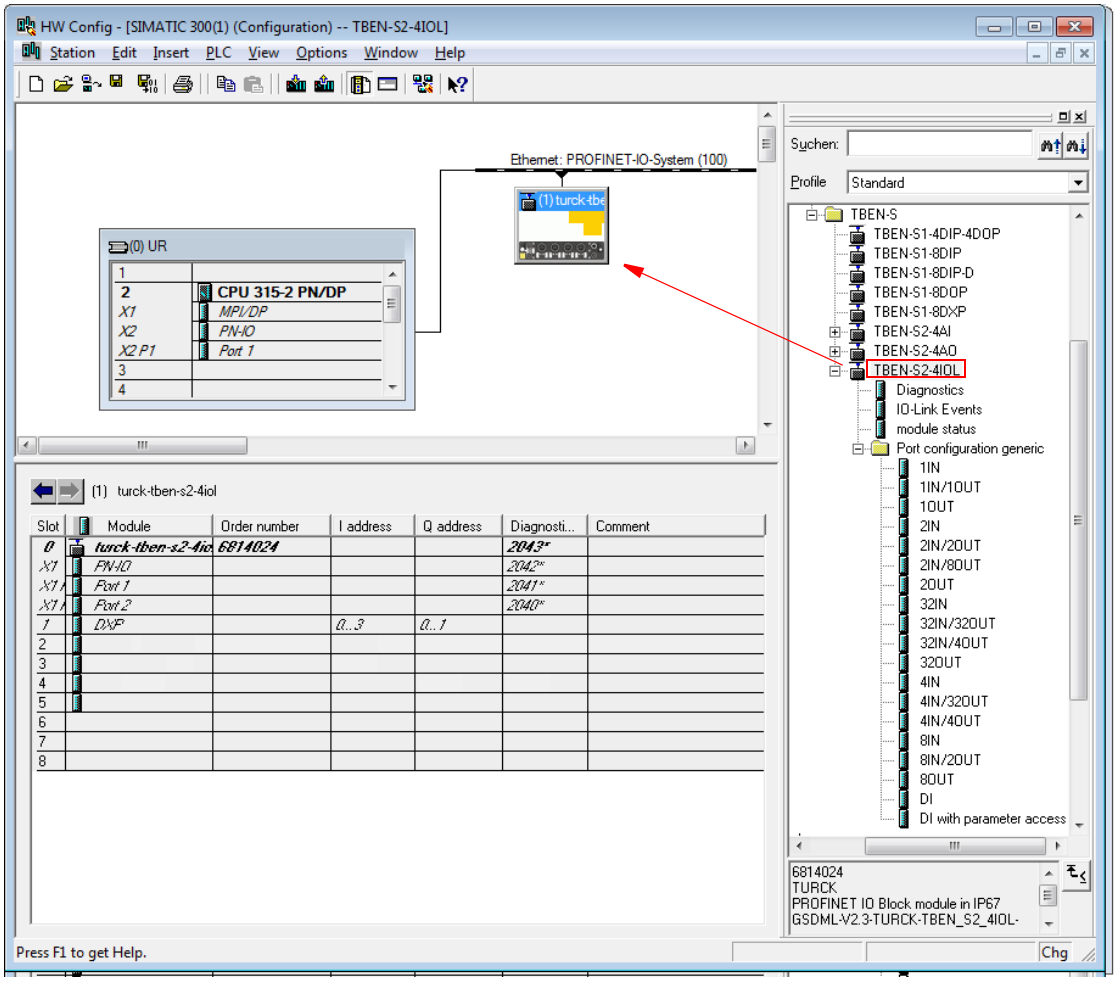


Figure 9-1: Adding a TBEN-S2-4IOL to PROFINET

The function of these slots is either defined via GSDML or can only be used for a specific purpose.

Table 9-1: Virtual slots in Step 7

Slot	Module/name	Meaning
0	*turck-tben-s2-4iol* (default name)	Main module, parameterization of device functions (deactivation of protocols, etc.)
X1	*PN-IO*	Parameterization of PROFINET functions (MRP, etc.)
X1 P1	*Port 1*	Parameterization of the Ethernet port properties (topology, connection options, etc.).
X1 P2	*Port 2*	
1	*DXP*	DXP-channels of the device (DXP 2, 4, 6, and 8)
2 - 5	variable	These slots are used for configuring the 4 IO-Link ports. Assign generic port configurations the IO-Link ports. Select the entries according to the amount of process data of the connected sensor.
6	Diagnostics	Optional mapping of the diagnostics (IO-Link and DXP-diagnostics) into the master's process image. (see page 4-6)
7	IO-Link Events	Optional mapping of the events (IO-Link and DXP-diagnostics) into the master's process image. (see page 4-6)
8	Module status	Optional mapping of the status (IO-Link and DXP-diagnostics) into the master's process image. (see page 4-6)

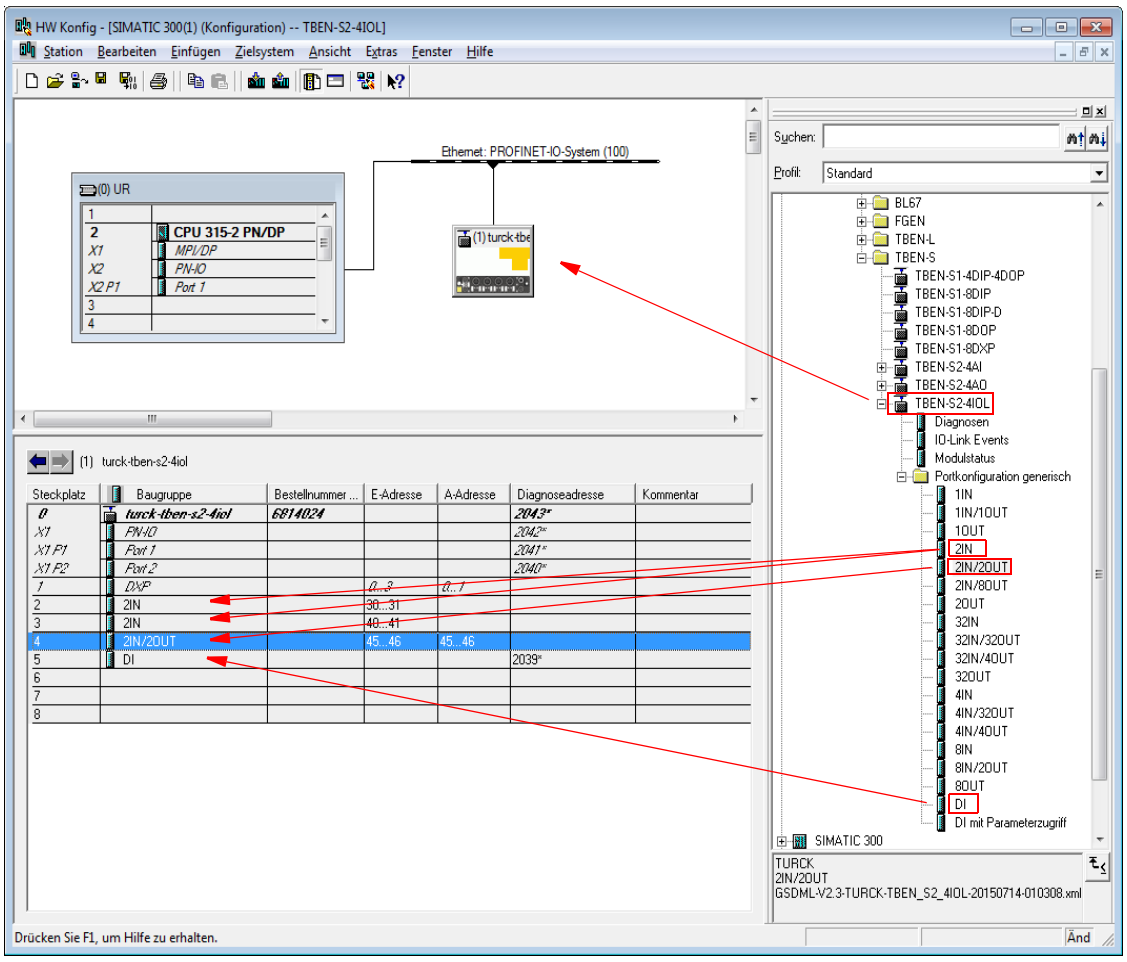
Configuration of the virtual slots 2 - 5 (IO-Link-ports) in the example project

see also Example project (page 9-2)

Table 9-2: Configuration of the virtual slots 2 - 5

IO-Link Port (Hardware)	virtual slot	Process data length	Sensor	GSDML-entry
1	2	2 byte IN	TURCK temperature sensor, TS-530-LI2UPN8X-...	2 IN
2	3	2 byte IN	TURCK linear position sensor, Li200P0-Q25LM0-...	2 IN
3	4	2 byte IN 2 byte OUT	TURCK I/O-hub, TBIL-M1-16DXP	2 IN/2OUT
4	5	1 bit IN	TURCK ultrasonic sensor, RU130U-M18E-LiU2PN...	DI: The IO-Link-port is only configured as DI.

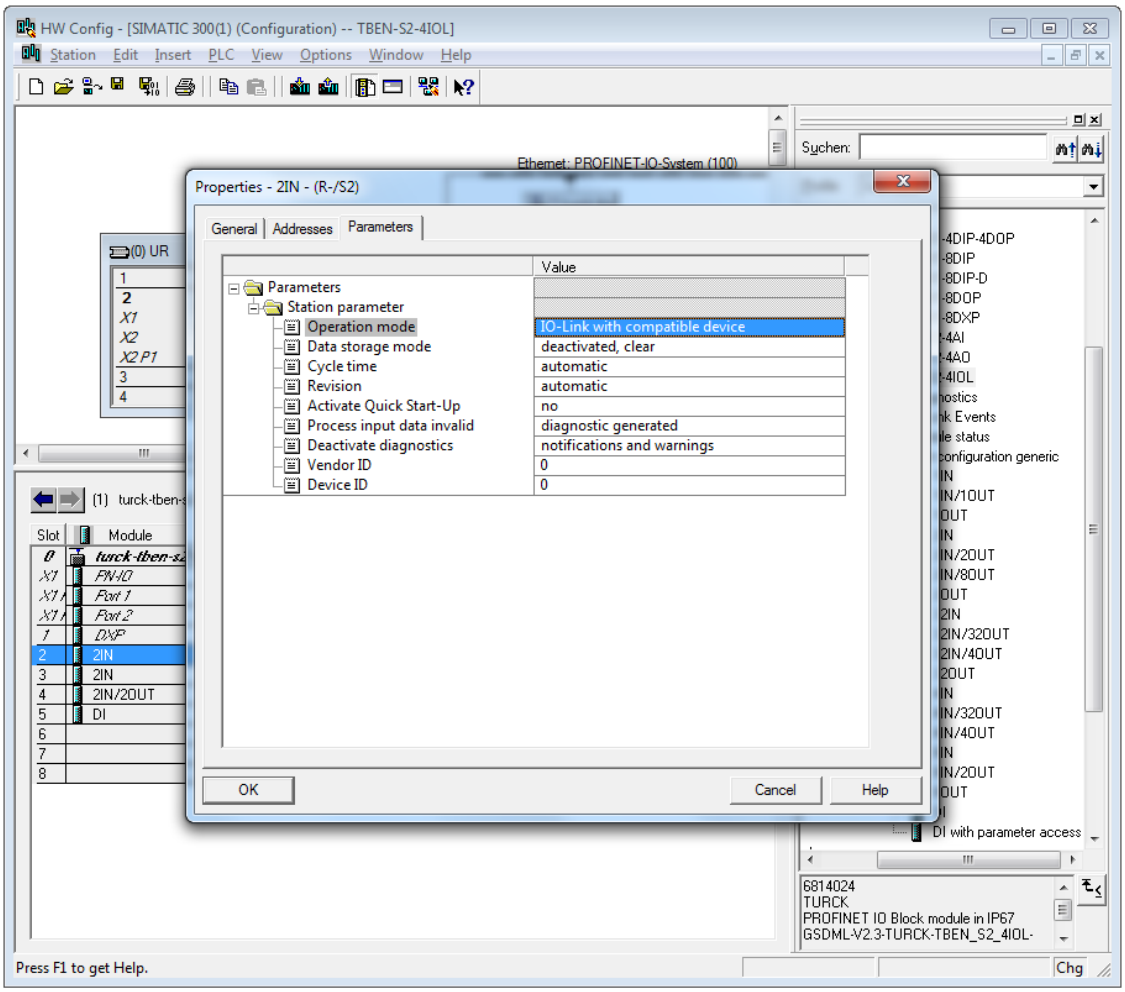
Figure 9-2: Configuration of the virtual slots 2 - 5



9.2.2 Parameterization of the IO-Link ports

The 4 ports of the IO-Link master can be operated in IO-Link mode with different configuration as well as in DI mode (see also parameter Mode (page 4-9)).

Figure 9-3: Configuration of the IO-Link ports



IO-Link-port parameterization in the example project

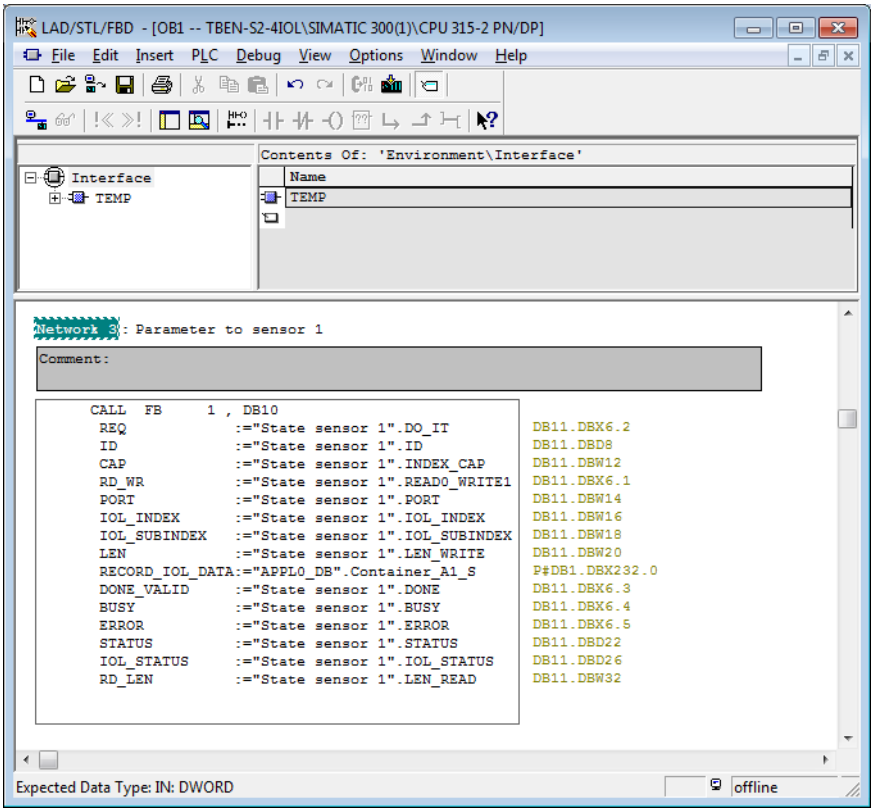
Table 9-3: IO-Link port parameterization in the example project

IO-Link-port	virtual slot	Parametrierung	Sensor
1	2	**IO-Link with identical device** → The master checks if the device type (vendor-ID and device-ID) and the serial number of the connected device match the data of the configured one.	TURCK temperature sensor, TS-530-LI2UPN8X-H1141-L016
2	3	**IO-Link without validation** → Every IO-Link device will be accepted as exchange device in case of a device exchange.	TURCK linear position sensor, Li200P0-Q25LM0-...
3	4	**IO-Link with compatible device** →Only an identical exchange device is accepted in case of a device exchange (check of vendor-ID, device-ID, etc., see also ,).	TURCK I/O-hub, TBIL-M1-16DXP
4	5	**DI**	TURCK ultrasonic sensor, RU130U-M18E-...

9.3 Usage of the function block in Step 7

The chapter 8 contains a general description of the function block and its in and output variables.

Figure 9-4: Example call of Siemens FB IO-Link-CALL (FB102) in OB1



9.3.1 Example accesses with IOL_CALL

In this example, the variable table "HMI" serves to visualize the procedure of the read and write access via IOL_CALL. The devices' process data are shown in the variable tables "Sensor1" or "Sensor2".

The assignment of the SPDU-indices of IO-Link devices can be found in the respective device documentation.

Read access

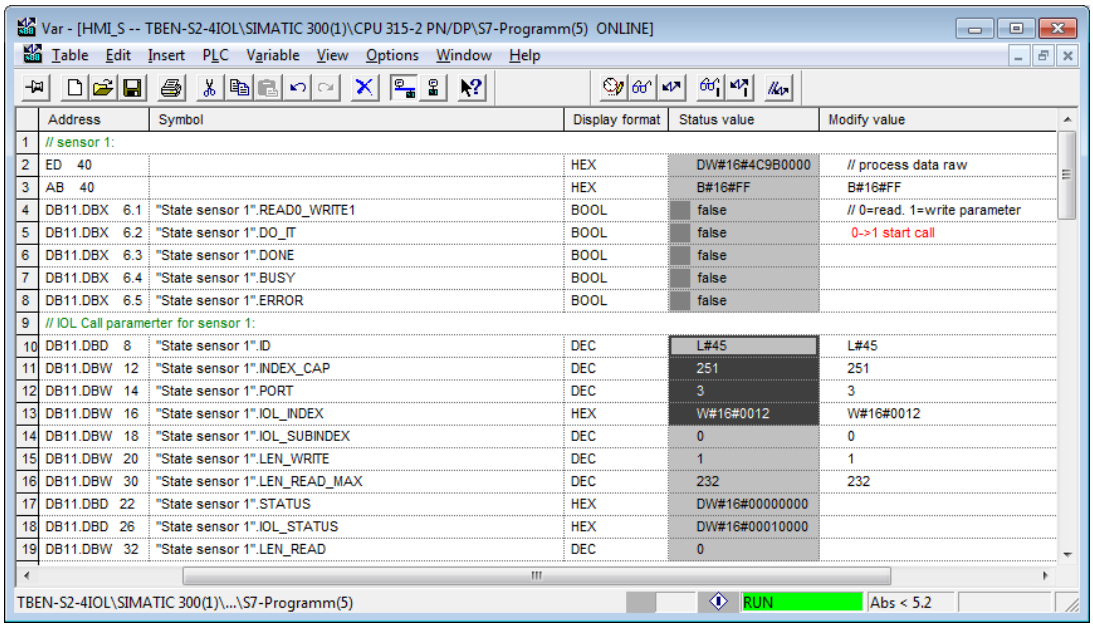
Reading out the product name (product name, index 0x12) of the TURCK IO-Link I/O-hub TBIL-M1-16DXP at IO-Link port 3.

1 Please write the function block's input variables as follows (description see above):

Table 9-4: Example input variables

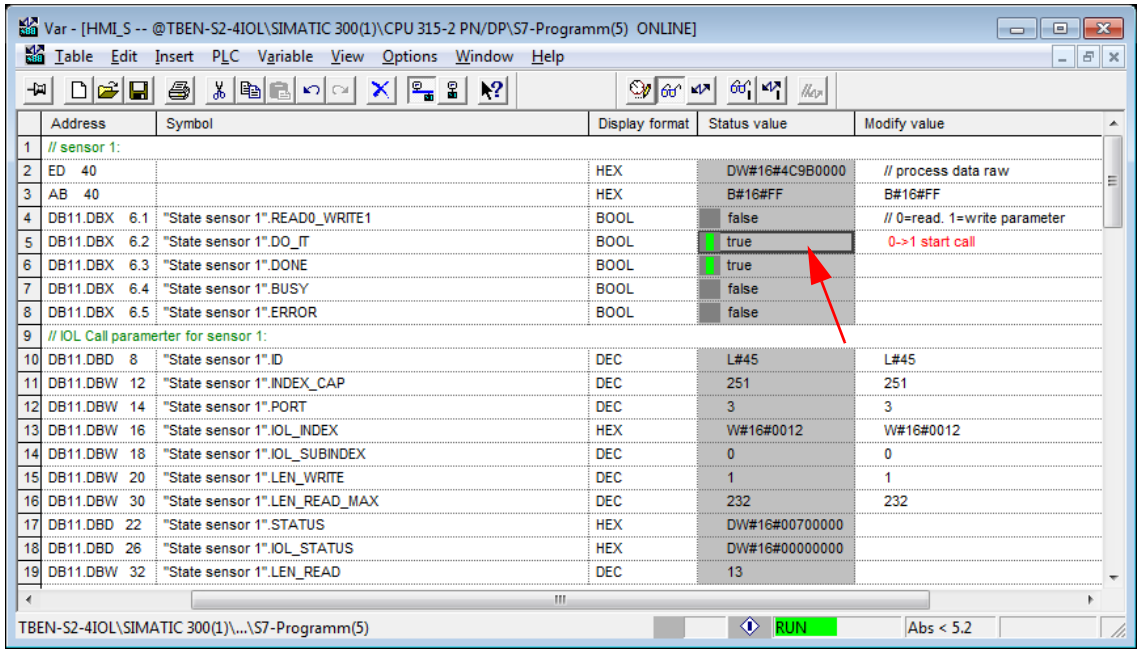
Variable	Value	Meaning
RD_WR	0	Read access
ID	45	Start address of the module's input data according to the configuration in HW Config, see siehe Figure 9-2: Configuration of the virtual slots 2 - 5.
CAP (INDEX_CAP)	251	Function block instance
PORT (ENTITY_PORT)	3	The IO-Link device is connected to port 4.
IOL_INDEX	0×12	Index for product name

Figure 9-5: Input variables for read access



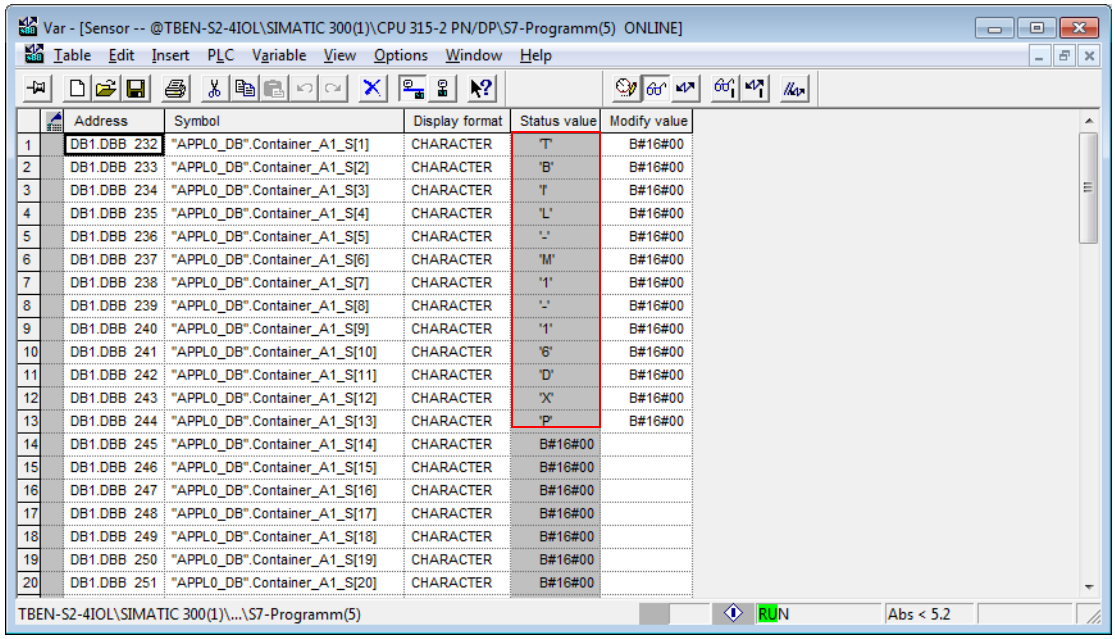
2 After this, the read access has to be activated via a rising edge at "REQ":

Figure 9-6: Activating the read access



3 In this example, the result of this request can be seen in the process data table VAT "Sensor 1".

Figure 9-7: Process data of the sensor



Write access

Changing the parameter "Measured value update time/rotating/disabling a display" (index 55) to the value 0x05 (600 ms measured value update time, display rotated by 180°) for the TURCK temperature sensor TS-500-LUUPN8X-H1141 at IO-Link port 1.

Figure 9-8: Extract from the documentation for TURCK temperature sensors

Temperature sensors TS series
IO-Link Parameters

Specific On-Request Data Objects – Parameter values

Index 0x54; Displayed unit

Value (hexadezcimal)	Menu item	Function
0x00	°C	°C
0x01	°F	°F
0x02	k	k
0x03	Ohm	Ohm

Index 0x55: Measured value update time/rotating/disabling a display

Value (hexadecimal)	Menu item	Function
0x00	50	50 ms measured value update time
0x01	200	200 ms measured value update time
0x02	600	600 ms measured value update time
0x03	r50	50 ms measured value update time, display rotated by 180°
0x04	r200	200 ms measured value update time, display rotated by 180°
0x05	r600	600 ms measured value update time, display rotated by 180°
0x06	OFF	Display disabled

Index 0x56: Behaviour of output 1 in the event of error

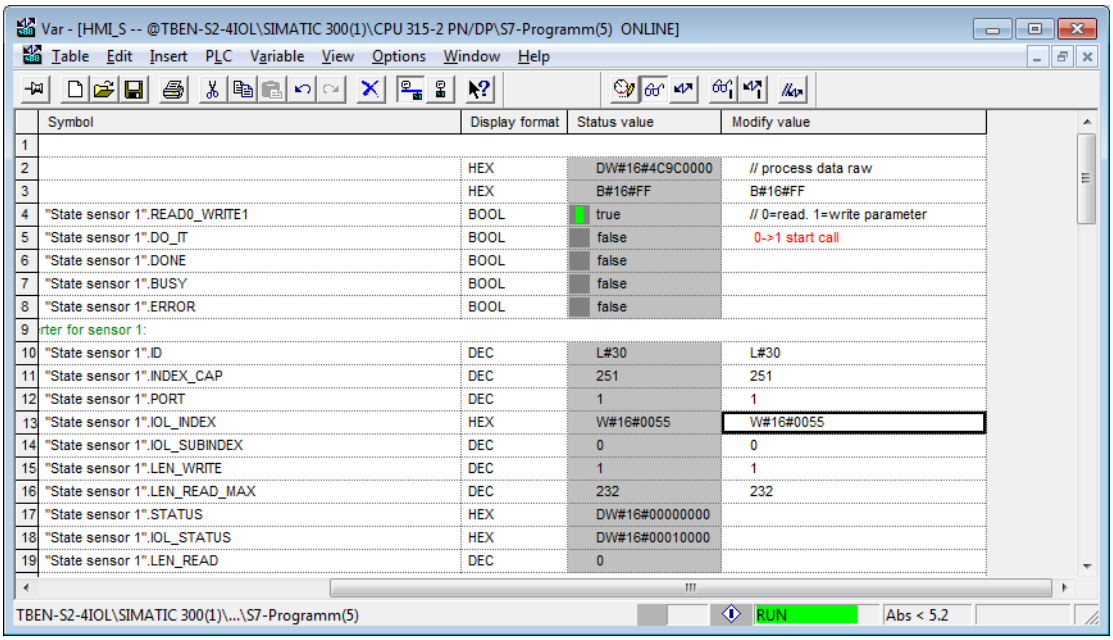
Value (hexadecimal)	Menu item	Function
0x00	Fou1	Output off
0x01	Fou2	Output on

1 Please write the function block's input variables as follows (description see above):

Table 9-5: Example input variables

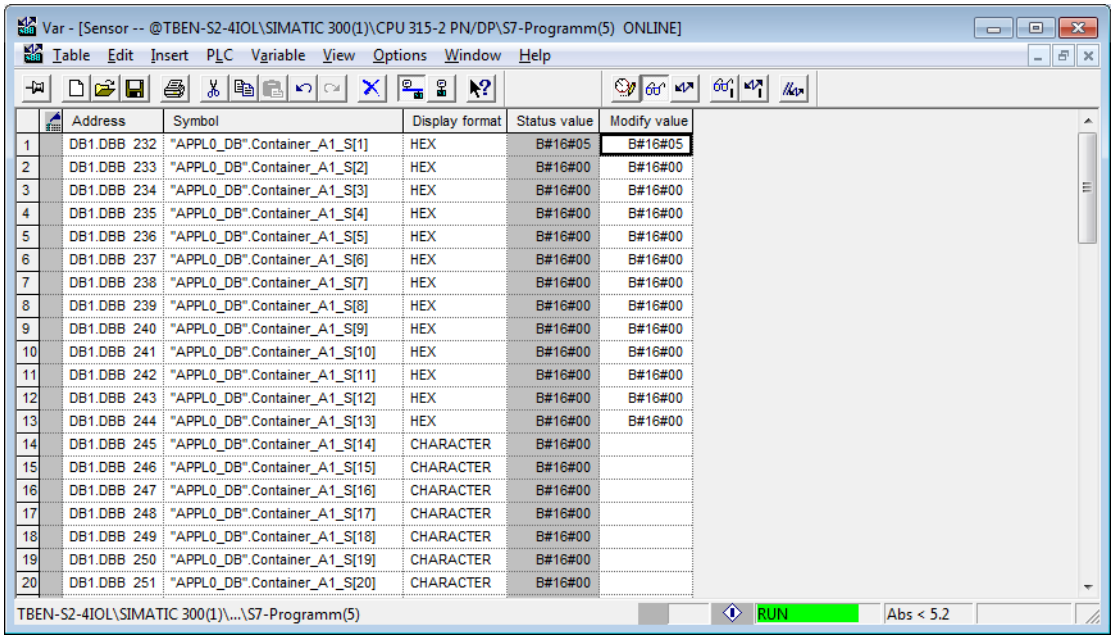
Variable	Value	Meaning
RD_WR	1	Write access
ID	30	Start address of the module's output data according to the configuration in HW Config
CAP (INDEX_CAP)	251	Function block instance
PORT (ENTITY_PORT)	1	The IO-Link device is connected to port 1.
IOL_INDEX	0×55	Index for "Measured value update time/rotating/ disabling a display", see above.
LEN_READ	1	1 byte is written.

Figure 9-9: Input variables for write access



2 The value to be written (0x05) is entered as control value in the variable table (VAT) and is then written.

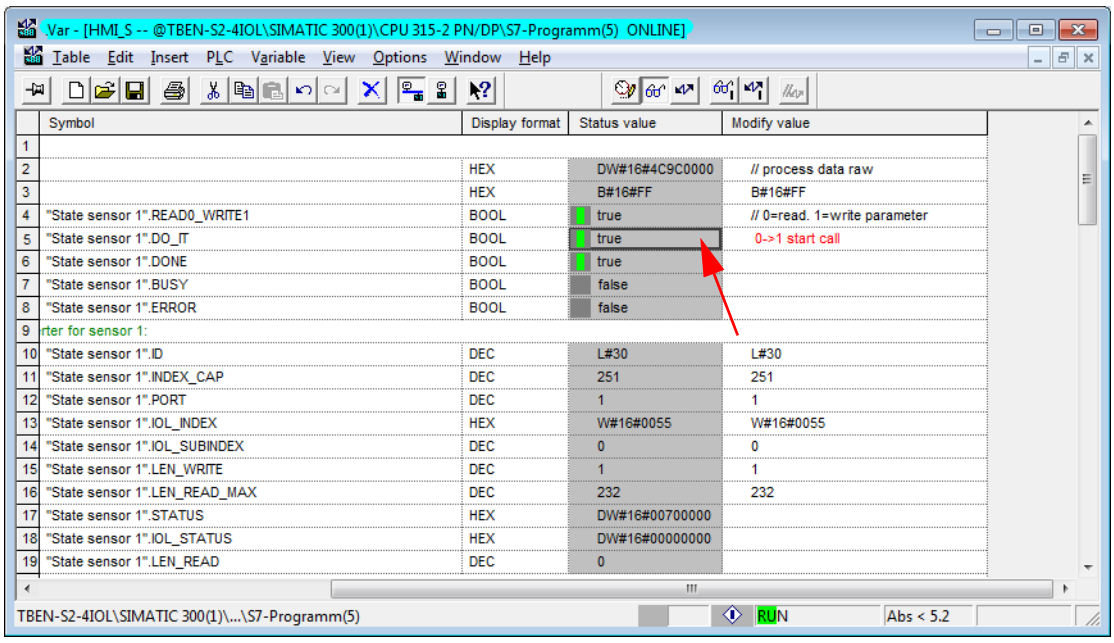
Figure 9-10: Control value for index 0×55



	Address	Symbol	Display format	Status value	Modify value
1	DB1.DBB 232	"APPL0_DB".Container_A1_S[1]	HEX	B#16#05	B#16#05
2	DB1.DBB 233	"APPL0_DB".Container_A1_S[2]	HEX	B#16#00	B#16#00
3	DB1.DBB 234	"APPL0_DB".Container_A1_S[3]	HEX	B#16#00	B#16#00
4	DB1.DBB 235	"APPL0_DB".Container_A1_S[4]	HEX	B#16#00	B#16#00
5	DB1.DBB 236	"APPL0_DB".Container_A1_S[5]	HEX	B#16#00	B#16#00
6	DB1.DBB 237	"APPL0_DB".Container_A1_S[6]	HEX	B#16#00	B#16#00
7	DB1.DBB 238	"APPL0_DB".Container_A1_S[7]	HEX	B#16#00	B#16#00
8	DB1.DBB 239	"APPL0_DB".Container_A1_S[8]	HEX	B#16#00	B#16#00
9	DB1.DBB 240	"APPL0_DB".Container_A1_S[9]	HEX	B#16#00	B#16#00
10	DB1.DBB 241	"APPL0_DB".Container_A1_S[10]	HEX	B#16#00	B#16#00
11	DB1.DBB 242	"APPL0_DB".Container_A1_S[11]	HEX	B#16#00	B#16#00
12	DB1.DBB 243	"APPL0_DB".Container_A1_S[12]	HEX	B#16#00	B#16#00
13	DB1.DBB 244	"APPL0_DB".Container_A1_S[13]	HEX	B#16#00	B#16#00
14	DB1.DBB 245	"APPL0_DB".Container_A1_S[14]	CHARACTER	B#16#00	
15	DB1.DBB 246	"APPL0_DB".Container_A1_S[15]	CHARACTER	B#16#00	
16	DB1.DBB 247	"APPL0_DB".Container_A1_S[16]	CHARACTER	B#16#00	
17	DB1.DBB 248	"APPL0_DB".Container_A1_S[17]	CHARACTER	B#16#00	
18	DB1.DBB 249	"APPL0_DB".Container_A1_S[18]	CHARACTER	B#16#00	
19	DB1.DBB 250	"APPL0_DB".Container_A1_S[19]	CHARACTER	B#16#00	
20	DB1.DBB 251	"APPL0_DB".Container_A1_S[20]	CHARACTER	B#16#00	

3 After this, the write access has to be activated via a rising edge at "REQ":

Figure 9-11: Activating the write access



	Symbol	Display format	Status value	Modify value
1				
2		HEX	DW#16#4C9C0000	// process data raw
3		HEX	B#16#FF	B#16#FF
4	"State sensor 1".READ0_WRITE1	BOOL	true	// 0=read. 1=write parameter
5	"State sensor 1".DO_IT	BOOL	true	0->1 start call
6	"State sensor 1".DONE	BOOL	true	
7	"State sensor 1".BUSY	BOOL	false	
8	"State sensor 1".ERROR	BOOL	false	
9	rter for sensor 1:			
10	"State sensor 1".ID	DEC	L#30	L#30
11	"State sensor 1".INDEX_CAP	DEC	251	251
12	"State sensor 1".PORT	DEC	1	1
13	"State sensor 1".IOL_INDEX	HEX	W#16#0055	W#16#0055
14	"State sensor 1".IOL_SUBINDEX	DEC	0	0
15	"State sensor 1".LEN_WRITE	DEC	1	1
16	"State sensor 1".LEN_READ_MAX	DEC	232	232
17	"State sensor 1".STATUS	HEX	DW#16#00700000	
18	"State sensor 1".IOL_STATUS	HEX	DW#16#00000000	
19	"State sensor 1".LEN_READ	DEC	0	

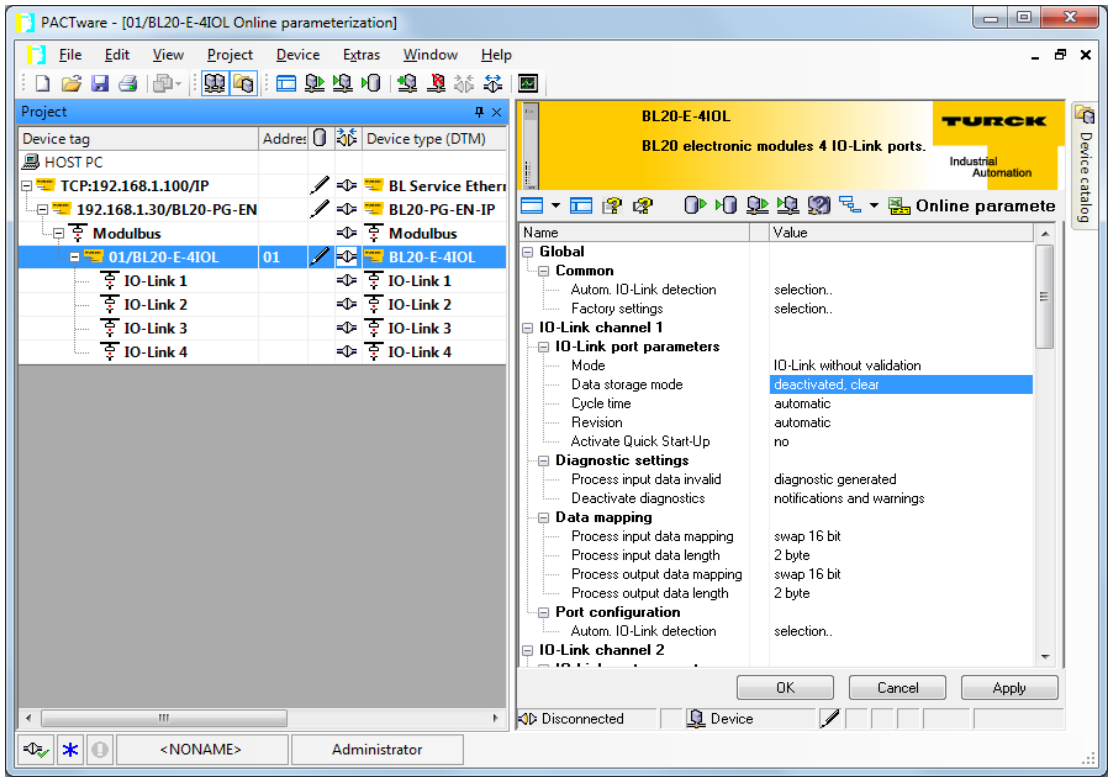
4 The sensor's display is now rotated for about 180°, the update time is set to 600 ms.

10 Appendix

10.1 Start-up: IO-Link-Device with IO-Link V1.0

In general, the following applies:
IO-Link devices in accordance with IO-Link specification V1.0 **do not support data storage**. This means, that the parameter "Data storage mode" has to be set to "deactivated,clear" if an IO-Link V1.0 devices is used.

Figure 10-1: Data storage mode deactivated, clear



Start-up steps

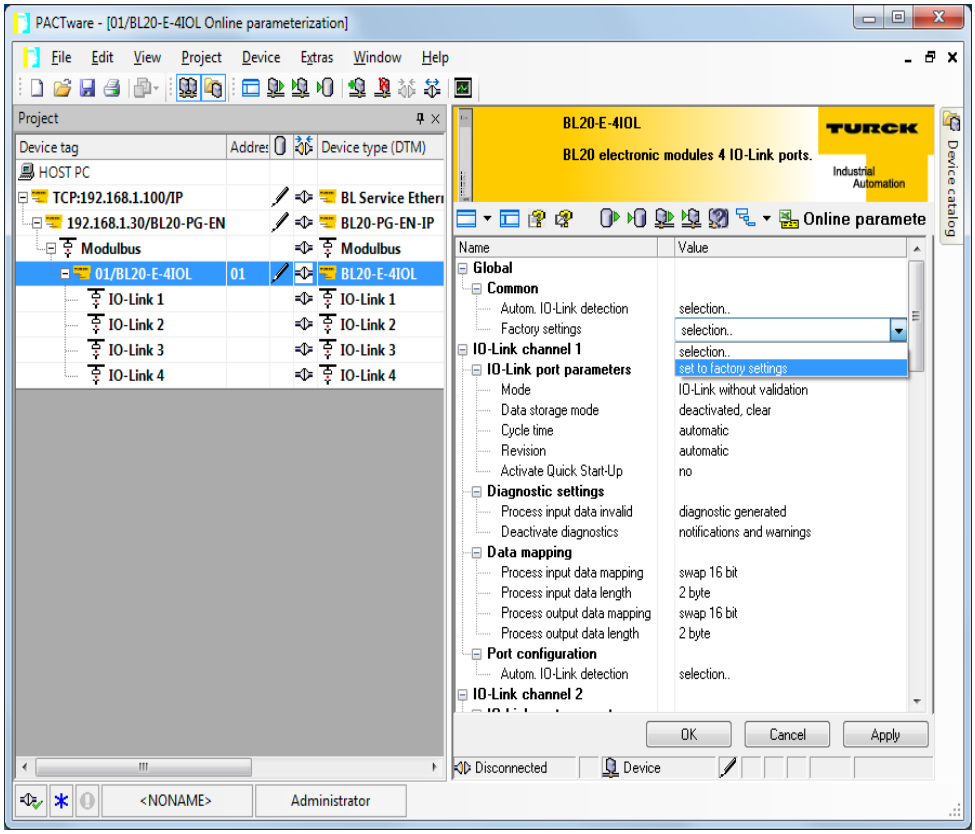
- ➤ Deactivate the data storage mode for the respective IO-Link port,
- ➤ Download the parameters into the device, all other parameters can be set to default settings,
- ➤ Connect the IO-Link V1.0 device.
- ➥ LED „IOL“ = GREEN (for the respective port), IO-Link communication is active

10.2 Start-up: IO-Link-Device with IO-Link V1.1

In general, the following applies:

- The data storage of the master should be cleared before a device with a different device type is connected to an IO-Link port which has already been used before.
  To do so, set the master back to factory settings or clear the data storage buffer using the parameter "data storage mode".

Figure 10-2: Reset master to factory settings



Start-up steps (1. possibility)

➤ Set parameter "factory settings" to "set to factory settings",

➥ The DTM resets the device automatically,

➤ Connect the IO-Link V1.1 device.

➥ LED „IOL“ = GREEN (for the respective port), IO-Link communication is active

Start-up steps (2. possibility)

➤ Set the "data storage mode" to "deactivated,clear",

➤ Download the parameters into the device,

➤ Re-activate the data storage if required,

➤ Download the parameters into the device,

➤ Connect the IO-Link V1.1 device.

➥ LED „IOL“ = GREEN (for the respective port), IO-Link communication is active

10.3 Start-up problems - frequently failure causes

LED	Diagnosis	Possible causes	Explanation/solution
DIA and **IOL** red, flashing	data storage error	IO-Link device in accordance with IO-Link V1.0 connected. IO-Link devices in accordance with IO-Link specification V1.0 do not support data storage	Deactivate the data storage. To do so, set parameter "Data storage mode" to "deactivated, clear", see page 4-11.
		The data storage buffer contains data of another device.	Clear the data storage buffer of the master. To do so, set the parameter "Data storage mode" to "deactivated, clear", seepage 4-11, and re-activate the data storage if necessary.
	Wrong or missing device	The connected device does not match the configured one (wrong vendor-ID, device-ID etc.).	Change the parameterization of the IO-Link port at the master. Correct the vendor-ID, device-ID, etc. The parameterization can be done by teaching the master via IOL_CALL using the port function Subindex 67: Teach Mode or via a manual port parameterization.
	process input data invalid	Certain IO-Link devices send a "process input data invalid"-diagnosis if the process value can not be measured.	Deactivate the sending of the "process input data invalid"-diagnosis for the respective port. To do so, set parameter "Process input data invalid" to "no diagnostic generated", see page 4-12.

11 Index

W

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